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Molding the New Cadillac Eight-Cylinder Motor

Details of an Intricate Foundry Job Which Involves a Large Amount of Difficult and Accurate Coremaking and Coresetting

By H C Estep

AUTOMOBILE cylinder work always presents interesting features to the foundryman, and in the manufacture of a high grade motor such as that in the new eight-cylinder Cadillac the methods adopted are worthy of careful study. The new Cadillac engine is of the V-type, the eight cylinders being arranged in two sets of four bolted to an aluminum crank case. Each set is cast *en bloc* and while the general method is somewhat similar to that employed for the production of ordinary four-cylinder motors, the requirements of the eight-cylinder engine are such that many refinements are necessary in its construction and in order to get suitable results, these refinements

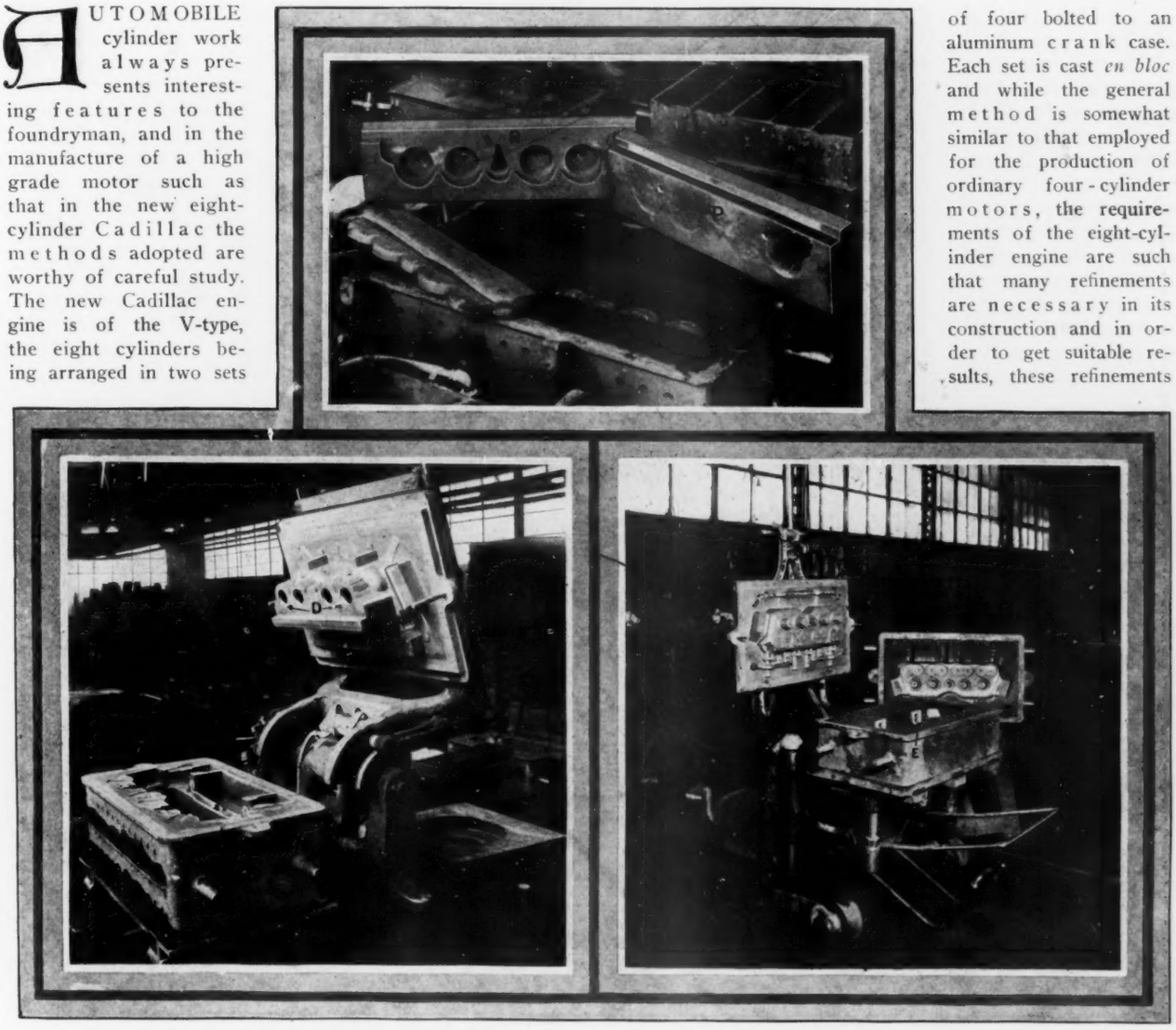


FIG. 1—DRAG MOLD SHOWING WOODEN TEMPLATE, LOOSE PIECE OF PATTERN FORMING CORE PRINT AND FOUNDATION CORE

FIG. 2—THE MOLD IS MADE IN GREEN SAND ON A JARRAM TURN-OVER DRAW MACHINE

FIG. 3—THE COPE IS HANDLED ON A PLAIN ROCK-OVER MACHINE

must be given as much consideration in the foundry as in the machine shop. The casting must be absolutely true to size and capable of taking a high finish; the metal must be extremely close-grained and free from porosity, yet not so hard as to interfere with the machining operations; also the cores must be of the correct size, accurately set and centered because the metal sections in many places are less than ¼-inch.

At the present time, the Cadillac foundry in Detroit is turning out 330 four-cylinder sets per day. This production requires the operation of nine molding machines and the employment of 33 men in the cylinder molding department. The work is handled on six floors, there being one jar-ram turn-over draw machine on each floor for molding drags. There are only three cope machines, one for each two floors, of the plain rock-over drop type. Three men are employed on each cope machine, together with four men on each floor; two of the latter are machine operators, while the other two set the cores and close the molds.

The casting is made in a green sand mold in a two-part cast iron flask, 15½ inches wide and 28 inches in length inside, the drag being 10¾ inches and the cope 7 inches in depth. To avoid inaccuracies, the parting between the cope and drag is planed to a machine fit and the flask pin holes are provided with hardened steel bushings. The cores, of course, are dry sand. The molds are sprayed with a mixture of sour beer and blacking and also are finished with plumbago. Special facing sands are used, the details of which will be given later in this article.

A plate or jig is laid on the mold while it is being dusted with plumbago in order to prevent graphite from getting into the gates. It is believed that the iron entering the mold is cleaner if the gates are kept free from plumbago.

The molders and their helpers work approximately from 5:30 a. m. to 2:30 p. m., with three-quarters of an hour for lunch. The finished molds are laid out on the floors, as indicated in the accompanying illustrations and are all poured at one time in the afternoon. A special gang is employed for pouring. The castings are shaken-out and the sand prepared for the following day's work by another set of men. The molders, therefore, confine themselves strictly to their special field of operation.

The drags are molded on 26 x 10-inch jar-ram turn-over draw machines furnished by the International Molding Machine Co., Chicago. As mentioned previously, six machines are employed, the production of each being about 55 molds per day.

With the machine in its normal position, the molder dusts off the pattern and places the flask on the pattern board. Then in order to prevent the sand from entering the holes in the pattern shown in Fig. 2, the wooden template *T*, Fig. 1, is employed. It fits over the dowel pins *D*, Fig. 2. After the template is set in place the mold is filled with sand and rammed with the jarring mechanism on the machine. The quantity of sand is regulated so that it will settle down to a level with the top of the pattern, leaving the wooden template exposed. After this operation is completed, the template is removed and replaced by the iron cover piece *P*, Fig. 1. This piece forms the cavity or print in which the foundation core *R*, Fig. 1, is set. The sand is tucked around the iron cover piece by hand, after which the mold is filled and jarred again in order to finish ramming.

As soon as the second jarring operation is completed, the mold is struck off and the loose iron cover piece *P*, is drawn from the sand, leaving the mold in the condition shown in Fig. 1. The foundation core *R*, which carries the prints for the barrel cores, is now set in place, after which it is covered with sand and butt-rammed. The mold is then rolled over on the machine, a special cast iron follow-board being employed. The pattern is drawn by the machine in the usual manner and the drag, except for the blacking and dusting operations, is completed.

This stage of the operations is shown in Fig. 2. In this illustration, the pattern has been drawn from the sand and is being returned to its normal position on the table of the jar-ramming cylinder. A light crane is employed to lift the drag off the machine and set it down on the floor.

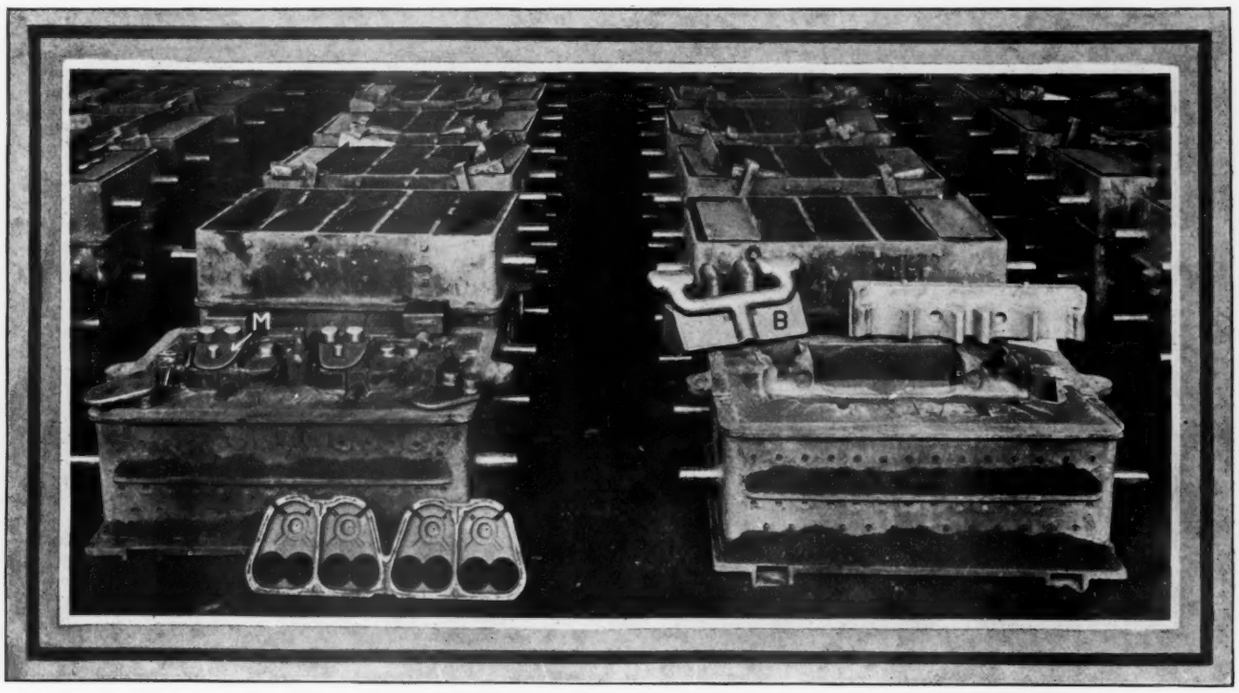


FIG. 4—THE FIRST STAGE IN THE CORE SETTING PROCESS IS SHOWN AT THE RIGHT AND THE THIRD STAGE AT THE LEFT

As mentioned previously, the machine is operated by two men. The facing sand for the drag molds consists of one-half new and one-half old molding sand, thoroughly blended and mixed with plain unbolted sea coal in proportions of 16 parts sand to one part coal. Wilburn No. 4 sand is employed and for back-filling the molds, sufficient new sand is mixed with the old floor sand to give satisfactory results, the molds being tempered with water. The sand is used in its natural state without the admixture of clay or other binders.

The copes are molded on plain turn-over draw machines furnished by the International Molding Machine Co., Chicago, and on rock-over drop machines furnished by Henry E. Pridmore, Chicago. Fig. 3 shows one of the machines employed for molding copes. The mold from which the pattern has just been removed is shown in the foreground and one of the finished copes may be seen in the background. The operations involved in molding the copes are simple. With the machine in normal position and the flask in place, the molder first places the gates and sprues, which are made in one piece, in their proper position, after which the flask is filled with sand, tucked and rammed by hand. Two men work at the machine, while a third patches and finishes the copes. After the pattern is drawn, four loose pieces, *E*, Fig. 3, are left in the mold. These are withdrawn by hand and the mold carefully finished. The facing sand for the cores is made of a mixture of one-half old and one-half new sand, which is worked into proper shape and mixed with bolted sea coal in the proportions of 16 parts sand to one part coal. The new sand which constitutes 50 per cent of the facing is prepared by mixing one part Wilburn sand with two parts Conneaut sand.

Figs. 4 and 5 show the method of setting the cores. The manifold cores for the inlet and exhaust passages are mounted on a block, as shown at *B*, Fig. 4. At the right of the manifold assembly, resting on the same mold, the large back core which forms one side of the cylinder may be seen. These two cores are set first, after which the barrel cores, jacket cores, combustion chamber cores, etc., are placed in position.

In the left hand mold, Fig. 5, the barrel cores are shown in place and the manifold block *B* may be seen behind them. In this illustration, the middle jacket core may be seen resting between the two molds; the top jacket core is lying on the sand in the foreground. This view shows the under side of the top jacket core.

In the left hand mold, in Fig. 4, the middle jacket cores have been set in place together with two of the combustion chamber cores *M*. The other combustion chamber cores may be seen lying on the edge of the flask, the one at the left being bottom side up. In the flask shown at the right in Fig. 5, all of the cores have been set in place and all that remains to be done is to set on the cope and clamp the mold.

All of the important cores are made on machines. For this purpose a large number of Pridmore rock-over drop core machines similar to those shown in Fig. 6 are employed. The machine shown at the right in this illustration is equipped to make top jacket cores, the one at the left being employed to make middle jacket cores.

The finished cores are shown plainly on the machine and the details of the metal core boxes which are used are clearly delineated. The jacket cores are made of a mixture of pure lake sand and oil in the proportions of 51 parts sand to one part oil. The smaller cores are made from a mixture of lake sand, bank sand, dextrine and oil. The core department of the Cadillac foundry uses approximately 12 tons of lake sand daily. The core sand is mixed in a machine furnished by the Standard Sand & Machine Co., Cleveland. In order to make sure that the foundry will have a constant supply of cores of suitable quality, all of the cores are assembled, gaged and tested in the core room, after which they are delivered to a store room from which they are drawn out on requisition by the molding department.

The castings are very carefully cleaned. Each set of cylinders is tumbled twice, sand-blasted and finally filed to a suitable surface. After they

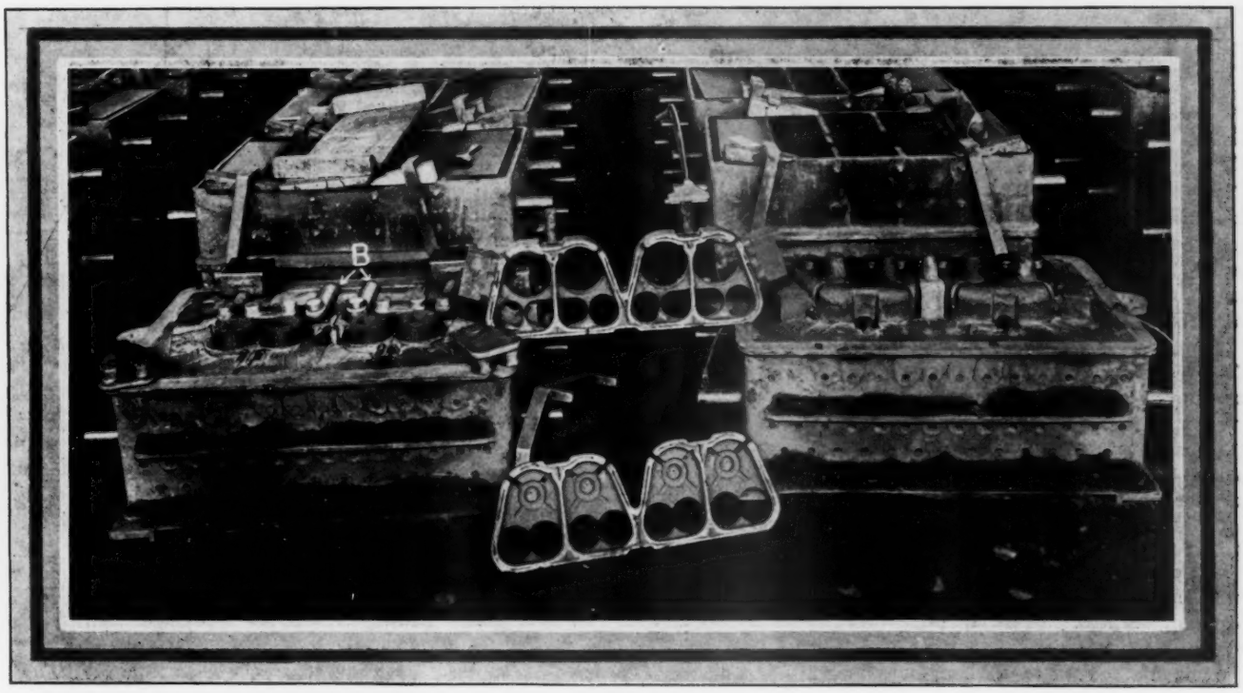


FIG. 5—AT THE LEFT THE BARREL CORES, MANIFOLD CORE AND BOTTOM JACKET CORES ARE SHOWN IN PLACE; AT THE RIGHT THE CORES ARE ALL SET AND MOLD IS READY TO BE CLOSED

FIG. 6—MOST OF THE CORES ARE MADE ON MACHINES

are finished and before they leave the foundry the cylinders are subjected to a water test of 100 pounds per square inch. One of the testing racks is shown in Fig. 7. This illustration also shows both sides of one of the cylinder castings. The testers are supplied with small electric lights so that the interior of the casting may be carefully examined for leaks and no cylinders are passed which are not absolutely tight.

Cylinder Mixture

The cylinders are cast from a mixture of Lake Superior charcoal pig iron, high-silicon northern pig iron, return foundry scrap and steel scrap. This is melted in a 72-inch cupola lined to 54 inches inside diameter. The iron is charged in rounds of 1,000 pounds with 135 to 140 pounds of coke per charge. Owing to the somewhat intricate design, the iron is run softer than would be necessary for simpler cylinders. The Brinell readings for hardness range from 187 to 196; formerly, when making single cylinders for the four-cylinder models, the hardness ranged from 212 to 217. The metal sections also were heavier than in the present case.

A close-grained iron, free from spongy spots, is secured by proportioning the mixture so that the casting contains approximately 2 per cent silicon, 0.2 per cent phosphorus and 0.7 to 0.8 per cent manganese. The combined carbon ranges from 0.45 to 0.55 per cent. By-product coke is used and the sulphur is kept in the neighborhood of 0.06 to 0.07 per cent. It is believed the use of charcoal iron tends to give a metal which machines better than if coke iron were used alone. The iron is melted as hot as possible. Service tests have indicated that the cylinders wear satisfactorily and as far as the Cadillac company has been able to determine, there is no trouble due to wear resulting from the softer mixture. It is necessary, of course, to use piston rings of a suitable hardness and to have the cylinders properly lubricated. The latter is taken care of in the design of the motor. Every effort is made to insure uniformity in the physical and chemical characteristics of the metal in order to avoid trouble in machining. This is insured by casting test bars every day, using a Keep testing machine; hardness determinations also are made with a Brinell machine and samples from the heats are frequently analyzed in the chemical laboratory.

In the iron for piston rings the silicon ranges from 1.60 to 1.80 per cent, phosphorus from 1.10 to 1.25 per cent and the manganese from 0.20 to 0.30 per cent. The Cadillac company also melts a soft iron for miscellaneous purposes in which the silicon averages 2.50 per cent with phosphorus approximately 0.40 per cent and manganese 0.70 to 0.80 per cent.

Brown Company Makes Sand-Blast Equipment

The Brown Specialty Machinery Co., Chicago, manufacturer of core-making, core-cutting and tapering machines, electric and pneumatic shakers, etc., is now manufacturing a complete line of sand-blast equipment, including revolving sand-blast barrels, rotary tables, hose machines, automatic sand-blast rooms, dust arrestors, etc. A number of new features are being incorporated in this line of equipment and it is stated that the revolving barrels and rotary tables are dustless, the sand feed being automatic.

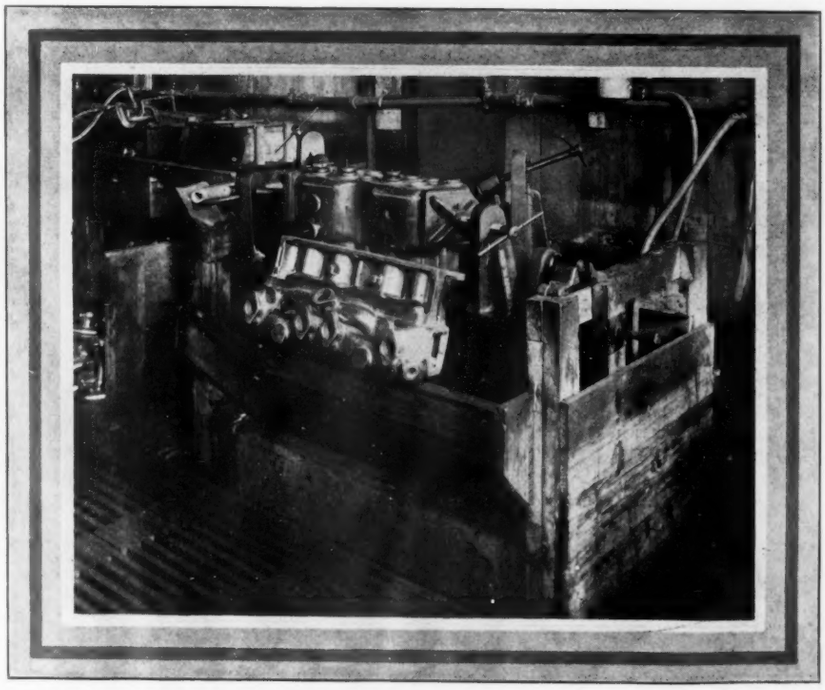


FIG. 7—THE FINISHED CYLINDERS ARE TESTED WITH 100 POUNDS WATER PRESSURE

Common Sense-Steel Foundryman's Great Asset

An Interesting Discussion of Steel Foundry Practice, With Practical Suggestions for Overcoming Difficulties

By S Muntz and S Roubieu

OF ALL the sciences which college professors tried to cram into our heads, geometry is that for which we have, perhaps, the fondest memories, probably because it teaches facts that will always appeal to the intelligence. Many of us have absorbed the innumerable theories and hypotheses of physics, chemistry and higher mathematics, while others, more fortunate (?) have gone as far as following such a philosophical genius as Liebnitz, in abstruse demonstration that 2 plus 2 makes 4; but the only good we have derived from these studies is a better knowledge of our own brain powers, so that our professors' teachings are remembered as pure gymnastics of our intelligence.

If you have often wondered why you adopted the steel business as a field of

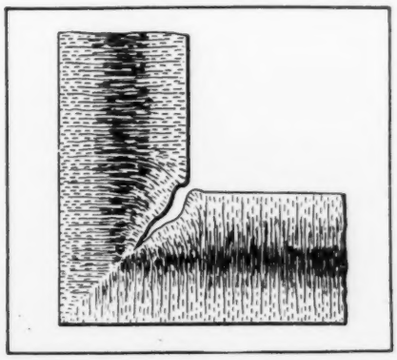


FIG. 1 — HOW CRYSTALLIZATION MAKES CRACKS AT CORNERS

endeavors you are one of many, and it is almost certain that, like the others, you simply answered the rather mysterious call of metallurgy in general, and of steel in particular; but you also discovered that as a continuation of previous brain exercises there is no greater source of satisfaction than that found in following our learned metallurgists in their researches on crystallization of steel; on allotropy in the iron-carbon system; and on the better thermal treatment of steel after it has reached a semi-finished stage.

We can then say that in our younger days we have studied and possibly learned, but as far as remembering what has been taught us, there remains almost a blank: we have forgotten nearly everything, but we are strong in the knowledge that if we need data on a certain subject, we will know where to look for it. Our previous education has simply made of us composite directories; directories for our own use.

We will, therefore, assume that we know where the information we require is to be found, and that once the information is obtained, our previous training will enable us to understand it. By natural sequence we come to the point where we are fully informed and when the only thing left to do, is to crystallize the information secured into plain everyday actions. This is where we find the greatest difficulty.

Common Sense as Applied to Steel Making

You may know something perfectly well, but you may not be able to take full advantage of your knowledge because the efficient application of known facts to the attainment of maximum results requires, among other things, discernment, tact, courage, speed of action, persuasion and confidence. In the steel foundry we must condense all these requirements into a particularly fine grade of common sense, and if this common sense, embodies all the above mentioned qualities we believe that no one will dispute our contention regarding the value of such an asset.

Knowing that we will bring the average melter or metallurgist to a high pitch of excitement, we will confess that we believe the actual steel making is the department where the least common sense is required. Once the problem is solved as to which melting method is to be used, steel will be produced according to fixed rules involving definite chemical reactions, and the resulting material will be an exact image of the operator's skill.

Assuming that the steel maker gives us good metal, his limitations will be those of the means employed, and no matter how skillful, he cannot produce a better steel than that which the furnace will turn out when efficiently used within its own field.

Very hot metal cannot be produced by the open-hearth process without endangering the life of the furnace; low carbon steel cannot be produced in plumbago crucibles although they can be produced in an electric furnace; very low sulphur and very low phosphorus steels cannot be produced in a converter; not because the operators are not efficient or lack in skill, but because the various methods have their own limitations.

Choosing a process to meet one's needs, does not require common sense, it necessitates only simple exercise of the brain, and the compilation of the data available in technical literature. Once the chosen furnace is installed it will respond to every whim of the melter, until it reaches the maximum which it cannot surpass. No matter how improved our melting methods will become, they will always be applied according to the rules of the originators. Subsequent improvements will be made, but they will never be effected by the application of common sense; they will result from

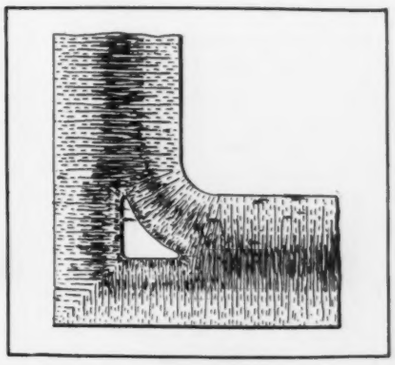


FIG. 2—HOW A FILLET CLOSES THE CRACK AND PRODUCES A CAVITY

greater practical experience, and their discovery is, therefore, but a matter of time.

The aim is the production of steel of such chemical analysis as will best meet our varied purposes in the present state of metallurgical knowledge. After the steel leaves the furnace, the real work will begin and from then on, common sense rules supreme.

We have reached the point where the melter, chemist, or metallurgist as the case might be, has given us steel of a certain chemical composition. With this steel, within our own sphere, we want to produce a steel casting. We make a mold, provide suitable gates and risers, pour the metal and a good casting ensues. Six months later, we make a similar mold, provide the same gates and risers, pour the metal and the result is

The authors are connected with the Tropenas Converter Co., New York, and this article appeared originally in the February issue of *"Steel Castings,"* published by the same company.

utter failure. Knowledge is necessary to explain what has happened, but knowledge without judicial application of common sense would fail most miserably. Let us therefore study this first trouble of the steel foundryman in the light of common sense.

Let us suppose that instead of being at work, the steel foundryman is at play, either at golf, tennis or football. After a certain time he will be quite overheated, and if he then sits on the cold ground or exposes himself to the cool air, he will catch a cold, which will be inversely proportional, in intensity, to the temperature of the ground or of the air; the lower the temperature, the greater the cold. Ordinary common sense teaches us to take such steps as will prevent colds and it is all a question of self-preservation dictated by the fear of reprisals from an abused nature. Such reprisals as our body has in store for sudden exposure, are also latent in molten steel. The melting period of the metal cannot be better compared than to the exercise of the foundryman at play, and as far as catching cold, the parallel is even stronger, when we pour the extremely hot metal into comparatively cold molds.

Pouring Conditions

Pouring conditions in the steel foundry change daily, almost hourly, and much trouble would be obviated if these conditions were more carefully observed, and steps taken to correct such variations as may occur. It is evident that molten metal will behave in as many ways as it is poured into molds at varied temperatures. It is, therefore, necessary to study the causes governing these occurrences.

The first factor in these changing conditions is the temperature of the metal itself. In the open-hearth furnace variations might be due to change in fuel quality, length of operations, bulk of the raw materials, conditions of operation, etc. In the converter process, silicon contents of raw materials, dryness of air blast, temperature of molten charges from cupolas or blast furnaces, contribute to a considerable extent to the variations of temperature in the metal ready to cast.

The second factor comprises the receptacles or molds in which the metal is poured. These vary in temperature almost as the weather and also with that of the foundry, which increases as the pouring of large quantities of metal goes on.

The third factor covers the humidity of both the air and the molds, which affects temperature on account of the amount of heat expended to dissociate the steam evolved under varying degrees of humidity. The intermediate receptacles, as ladles, used to carry the molten steel, need not be considered, as they are under easy control so that the steel, once in them, will represent almost the same variations in temperature as when it left the producing furnace.

We are therefore in presence of metal, which at the time of casting, is at a temperature that can only be ascertained at great cost of time and is consequently often guessed at; we pour it into lukewarm molds in the summer and almost frozen ones in the winter. The result is that if we are content to duplicate exactly the molding operation, success will be uncertain.

In the case of a casting apparently molded twice in identical fashion at different periods, failure can only be ascribed to changed conditions of temperature. The steel was either too hot or the mold was colder than usual, and the metal, upon catching cold, sneezed and coughed, causing hot cracks or shrink holes in places where they had not been expected. The conclusion is that the steel foundryman had reproduced all the desiderata of success until he forgot to consult his calendar or his thermometer. Temperature conditions were not duplicated, steps to offset the change were not taken, the steel was peeved at the oversight and caught cold.

As we go ahead, we reach more and more complex problems. The metal is now in the mold and is solidifying. Steel contracts when passing from the molten to the solid state, but it also crystallizes and the two phenomena of contraction and crystallization will have to be studied in order to determine how they hamper or help each other while taking place simultaneously.

Expansion or contraction of steel are in themselves very simple subjects of analysis. If the steel were poured in an ideal mold in which the walls would have no capillary action on the solidifying mass, and if the final casting was of such shape that one part would not cool more rapidly than another, then our problem would be simple and we would not need to trouble our heads so much about risers.

Feeding Steel Castings

Unfortunately, steel castings are made in sand molds, in which the walls are of such nature as to cause the metal to cling to them, so that it will sink faster at one spot than at another. Furthermore, the great majority of the castings are of irregular shapes and sections. One part will cool faster than the one next to it, there will occur pulling and straining, and if the casting is not properly fed there will be trouble a-plenty. This question of feeding steel castings is about the most arduous the steel foundryman has to face. Volumes and cyclopedias could be written on the subject, but no amount of teaching will replace good, hard-headed common sense, when groping for a solution of this problem.

To feed cooling metal, we have to draw on another mass of cooling metal, and as far as steel castings are concerned, there can be no general rule as to how this auxiliary mass of cooling metal should be located or as to what bulk it should have. This might explain why many a steel casting shows a hole under a riser, the object of which was to avoid just such cavity. If the riser is smaller than the part it is to feed, it will cool first and will reverse its purpose by feeding on the casting, so that the latter will either be spongy or its final shape will be at variance with the original pattern. If the riser is too large, part of it will be absolute waste. There exists, therefore, a happy medium, which is to be found only in the realm of common sense.

The Solidification Problem

The hope has been entertained that the study of cooling ingots would prove a valuable parallel to what happens in the steel foundry, but the sooner this fallacy is exploded, the quicker the steel foundryman will succeed in his field. A steel casting in the process of solidification might, however, be compared to an agglomeration of cooling ingots of different sizes, each of which acts for itself and most of the time at the expense of its neighbors. Risers of different sizes and shapes must, therefore, be provided at various locations to offset this battle royal of component parts cooling each as it can and often as it pleases. If taken integrally, the above assertion would mean the placing of risers over almost the entire area of the cooling surfaces. That is why common sense is again to be called upon, whereby one part of a casting is made to feed on another, the latter feeding on the next one and so on, until we reach a riser which feeds the last and most abused portion.

We then come to the crystallization part of the solidifying process. Before common sense can be applied we must recall the one and only general law concerning the formation of crystals; *no matter what final form or system will be assumed, crystallization will always take place perpendicularly to the cooling surfaces.* In a casting, the cooling surfaces are all those in contact with the mold and cores so that the lines of crystallization, will in the usual mold, be orientated in every direction. The two sketches, Figs. 1 and 2, illustrate better than words what we mean.

Fig. 1 explains the why and where-

fore of fillets in castings, while Fig. 2 shows the direct effect of a fillet. In Fig. 1 we see why a sharp corner will be weak due mostly to a break occasioned by interfering lines of crystallization. In Fig. 2 we remedied this weakness, but we created a body of metal larger than the neighboring ones, and the latter, freezing first, feed on the former, creating a cavity. This is another instance where nature seems to take things in its own hands, by trying to render all sections uniform. The last example shows in how poor harmony crytallization and contraction work. We went to the trouble of providing a fillet to help crystallization and then contraction steps in, occasions a cavity and destroys most of the gain we anticipated making. Here common sense becomes taxed to the utmost. Feeding by risers does not usually avail in this case, and forceful means must be devised to handle the situation. We usually resort to chills, so that the larger body of metal through greater speed of cooling will freeze as fast as the neighboring smaller ones.

Chilling, as far as the means of practicing it is concerned, is one of the best exercises for imagination and incidentally for display of common sense. Some use nails or bars of steel protruding in such part of the mold where the large bodies of metal will be located, others use chills against such surfaces as must be rapidly cooled. As far as advocating any particular method is concerned, it is useless, as in the steel foundry no two cases are alike. Each requires special diagnosis and corresponding treatment. There are no absolute rules and regulations for the production of sound castings and the only medium where the steel foundryman will find solace is in his own common sense.

Common Sense as Applied to Solidified Metal in the Semi-Finished State

What is solidified metal in the semi-finished state? In our case we will define it as being a steel casting which most steel foundrymen will be glad to ship as it is. It is sound, true to pattern and comes well within the chemical requirements of the customer's specifications. The chemist or metallurgist and the steel foundryman have apparently worked in perfect harmony, "everybody is happy," the casting is considered by many as ready for shipment, while others, not entirely satisfied, will proceed with physical tests.

In the second case a most extraordinary thing often happens; the physical tests prove the casting to be a failure. Such a perfect piece of workmanship cannot be wasted, and because we have heard of the benefits derived from annealing, we resort to it half-heartedly. A new test is made and failure is again recorded. To obtain a glimpse of what has happened, let us give an example.

Assume a casting provided with several test pieces, and let the annealing process be repeated at various temperatures. If for the sake of simplicity, we disregard chemical analysis, the results will, as experience shows, average about as follows:

Annealing temperature. Centigrade.	Tensile strength. Pounds.	Elastic limit. Pounds.	Elongation in 2 inches. Per Cent.	Reduction of area. Per Cent.
Not annealed	67,300	32,700	14.6	17.0
750	66,700	32,000	8.1	14.2
800	70,280	34,100	20.7	28.2
850	72,960	39,800	22.5	29.7
900	72,700	38,400	20.0	26.7
1000	74,100	37,000	14.0	20.4

An explanation is useless; the figures speak for themselves and prove that many a crime is committed in the name of annealing. Common sense does not avail much in this case, except that it will drive the steel foundryman to study the direct effect of heat when applied to steel in the semi-finished state. And it is at this point that the trouble begins.

We consult authorities and we are faced with theories and controversies of the most bewildering character. Allotropy, carbon and subcarbide theories, solution hypothesis, etc., are encountered and after a few more remarkable additions to his vocabulary the steel foundryman will throw up his hands in despair and wonder what our learned metallurgists are "driving at."

It is human that we should fail to use our most sterling qualities when we need them badly, and in the present case, the greatest asset of the steel foundryman should be, not only taxed, but abused, to force the mind into the proper channels.

Let us again consider the steel foundryman at play. This time there is no over-exertion on his part, he has been reasonably successful and has purchased an automobile. He has been driving over smooth roads when suddenly he comes to one of those bumpy highways in which this country abounds. The family jumps and thumps about in the car and all of a sudden there is a jar, the sharp report of breaking metal and the foundryman finds himself in a wreck. An axle has broken, or some of the gears have lost their teeth.

Through force of habit, the steel foundryman will examine the metal fracture and if it appears sound, will ascribe the trouble to weakness of design. He might be right and he might be wrong, but it is safe to say that with the present knowledge of the resistance of metals, there are more chances that he will be wrong. To save tires, automobile manufacturers strive to make lighter cars, and as weight cannot be reduced at the expense of safety, the component parts of metal must, therefore, be made lighter but of materials of greater unit strength.

The accompanying table of physical properties shows that under proper annealing decided improvements can be obtained, but if we should stop at this point we would have solved only a small part of the problem. It behooves us, therefore, to become more intimately acquainted with steel for casting purposes. When we considered steel passing from the molten to the solid state, we dwelled on crystallization, but inasmuch as contraction stepped in to make trouble, we could not, at the time, study the properties imparted to steel by different crystalline structures. It would also have been useless, because the freezing and cooling steel casting was considerably restrained in its natural contraction by the resistance of the mold and was transformed into a real accumulator of strains which only await an opportunity to assert themselves. The finished casting is, therefore, a composite of crystals held together by cohesive power and of strains which, if properly encouraged, will cause fractures. Until recently these strains absorbed the entire attention of the steel foundryman, and for most, a simple reheating with subsequent slow cooling remedied the trouble.

Temperature of Reheating

The table already referred to shows, however, that the temperature of reheating has considerable importance and that it is possible while destroying strains to so change the crystalline structure as to render the casting worse than it was at first.

This has been appreciated but has sometimes resulted in the most extraordinary conclusions on the part of certain steel foundrymen. As a chracteristic example we will only mention the one who advocated no annealing to save his firm $50,000 a year. Let us, therefore, disregard annealing as a means of destroying strains and let us begin a better acquaintance with the crystalline being of the steel casting.

The process of solidification of steel is not a gradual transition from the liquid to the solid state. It is a process of crystallization which means a definite physical change acompanied by an evolution of heat. We are thus in presence

of a liquid body which is simultaneously under two contradicting influences. The formation of crystals is, on the one hand, enhanced by the external cooling agents, and on the other hand retarded by the internal evolution of heat. It is, therefore, evident that there exists a tendency within bodies of solidifying steel towards equilibrium between radiating and evolved heat, and if conditions are favorable the latter will gradually become equal to and later surpass that lost to the external cooling agents, so that an actual increase in temperature of the mass will be evidenced. This is noticeable in iron and steel and at that moment the metal is said to recalesce, which explains the name of "recalescent point" used to define this paradoxical occurrence.

Recalescent Point

Once the recalescent point is reached the steel has assumed a definite structure and it ensues that if this structure is to be absolutely obliterated because it is not suitable for the purpose intended, the metal will have to be brought back to a well defined temperature, which will be superior to that of the recalescent point. It is also evident that crystallization will occur more and more slowly as we reach greater distance from cooling influence and inasmuch as crystals will be inversely proportional in size to speed of cooling, the texture of the inner bodies of metal will be coarser than that of the outer portions. This explains why in a steel casting we are confronted by textures differing widely in various sections. Coarse crystalline structures are weak, while a fine grain is conducive to strength; the best results from a casting require, therefore, a fine and uniform crystalline body.

While the casting is cooling in the mold, it is needless to trouble about crystalline structures. The main desire is then to produce soundness and trueness to pattern. But after the casting has been liberated from sand, gates, risers and fins, treatment should be applied so that every particle of the metal will possess the maximum possible strength.

We can now realize that heating slowly to a well defined point and subsequent slow cooling, after temperature equilibrium has been maintained for some time, will result in making the crystalline structure more uniform. That is the entire theory of annealing. This article, however, is not the place to advocate any particular temperature at which annealing should be done. As a matter of fact this temperature changes with the chemical composition of the steel, and the foundryman, must then suit his annealing to each particular case.

Outside of plain annealing, there must also be considered the different crystalline structures brought about at various temperatures. It is evident that certain textures will be conducive of better physical properties than others, and as some of them appear at high temperatures, common sense wonders as to the means of their preservation under ordinary conditions. If we heat steel to such a point as we know will insure the proper crystalline structure for the purpose intended, we must also devise means of preserving it. This we do by quenching. Here again is where the steel foundryman can exercise both his brains and common sense. Quenching media can be compounded to suit every fanciful imagination; we can use cold water, lukewarm water, brine, lead, acidulated water, oil, etc., but as usual, in the foundry, to the minimum frills will correspond the best results.

Experience has taught the steel foundryman that there is very little gratitude to be expected from purchasers of steel castings. Specifications are becoming more and more rigid, greater skill is expected to meet them, but still customers will "shop around" and often will leave a foundry that has given them entire satisfaction and that has perhaps taught them their actual knowledge of steel castings. This is, however, the privilege of he who buys, and common sense must lead one to be good natured and accept the situation as it is and not as it should be.

The Price Question

It is very easy to cut prices, and for the steel foundryman who knows his trade, it is child's play to meet such cuts within reasonable limits. It must be said, however, that if costs are well known, and if profits are fair, such cuts cannot be met honestly. For instance, castings bought under specifications are provided with test pieces. Chemical requirements are easily met and if the test piece fulfills the mechanical requirements, the steel foundryman is supposed to have satisfied all the terms of his contract. The true foundryman knows that a steel casting can be so treated that the test piece will answer all the requirements, while the casting itself will be a failure. To the unscrupulous, this is an excellent way of cutting prices by saving on costs. In the long run, there is no economy in saving by impairing quality and many a purchaser has found out the truth of this statement, at his expense, while trying to save by accepting lower quotations.

There are many reasons why the steel foundryman deserves the same regard as we have for our personal attorneys and physicians. The steel casting business is one where precedents do not count; problems change daily and previous experience is useful only so far as it shapes the mind, and enables greater ease in the solution of new puzzles. This will be recognized some day, but in the meantime the lack of recognition must be faced good naturedly by the steel foundryman.

On the other hand, one's common sense varies daily in intensity. We are all duller some days than others, we make mistakes. This is where good nature steps in and forces us to greater efforts by discounting discouragement. Inasmuch as our problems are difficult, let us face them smilingly, and let us forbid common sense from interfering with our happiness, by judicious culture of a sense of humor.

Electric Furnace for England

The Snyder Electric Furnace Co., 53 West Jackson boulevard, Chicago, has received an order from the Daimler Motor Car Co., of England, for an electric furnace having a daily capacity of four tons. This furnace will be operated on a refining basis and will melt cold material. This is the fifth Snyder furnace sold in Europe in the last two months.

The Daimler Motor Car Co. at present is manufacturing aeroplanes for the British government in addition to its line of automobiles and motor trucks. The steel supplied by the Snyder furnace contracted for will be used in the manufacture of castings for aeroplane motors.

G. J. Stock, formerly manager of the Stock Oil-Fired Converter Co., has disposed of his interest in that company and now is English representative for the Snyder Electric Furnace Co., with headquarters at Darlington, England.

Concrete Foundry Buildings

A 16-page booklet has been issued by Adolph Suck, architect and engineer of industrial plants, Hyde Park, Mass., which is devoted to reinforced concrete buildings designed and built by his firm. Illustrations of some of the structures designed and built and shown in this booklet include a concrete machine shop for the Marshall Electric Co., Hyde Park, Mass.; warehouse for the Case Mfg. Co., Unionville, Conn.; plant for the United Wire & Supply Co., Pawtucket, R. I.; coal storage for W. G. Morton, Albany, N. Y., and a number of large concrete structures for woolen mills in the New England district. Building plans are furnished complete, showing details of every column, beam or floor slab, thus securing for the owner bids made on the same basis and under the same condition. In addition, only such material is specified which can be purchased in the open market.

Interesting Tests of Vanadium Iron Castings

Results That Can Be Obtained From the Use of Pig Iron Containing Small Percentages of Vanadium and Titanium

SOME interesting tests have recently been made by Prof. Edwin O. Fitch Jr., Lafayette College, Easton, Pa., on the effect of vanadium in gray iron castings. No. 2 foundry pig iron made in the furnaces of the Thomas Iron Co., Easton, Pa., was used; it contained an average of 0.04 per cent vanadium and 0.022 per cent titanium, together with 2 per cent silicon. The other elements in the pig iron are given in Table II. Eight series of tests were made in order to determine the characteristics of castings with varying percentages of scrap. The proportion of scrap ranged from nothing up to 80 per cent. Two tests were made on semi-steel, there being 10 per cent steel and 40 per cent gray iron scrap in one of the mixtures and 20 per cent steel with 30 per cent gray iron in the other. The same gray iron scrap was used in the first six tests, a different scrap being employed in the semi-steel tests. In the words of Prof. Fitch, "The object of the tests was to determine the physical characteristics of the iron itself and when mixed with different proportions of scrap and to determine the most economical mixture of pig iron and scrap for different classes of castings."

In making the castings ordinary foundry conditions were duplicated as far as possible. A 35-inch Colliau type cupola installed in the foundry of the department of mechanical engineers of Lafayette College was used. Jamison 72-hour foundry coke was employed in all of the tests. No flux was used. It not being necessary to cast a large quantity of metal, only one round was charged for each test. Approximately 900 pounds of iron were melted in each test.

Making the Tests

The tests given in the specifications of the American Society for Testing Materials for gray iron castings were made with the following exceptions. The arbitration bar described in these specifications is 15¼ inches by 1¼ inches in diameter with 1/16-inch draft. The tensile specimens, however, call for a finished outside diameter of 1¼ inches. In order to obtain a standard tensile specimen, it was thought best to make the test bars 1½ inches in diameter. This made it possible to turn up the tensile test bars from the bars broken in the transverse tests.

It was not possible under these conditions to compare the breaking loads with those given in the American Society for Testing Materials' specifications. Nevertheless the figures covering the breaking loads are interesting as an indication of the strength and resiliency of vanadium iron castings and they are therefore included in Table I. In order, however, to compare the results obtained from the transverse tests with the requirements of the specifications, the moduli of rupture (outer fiber stress in pounds per square inch) were computed and compared with the calculated moduli of rupture of the specified arbitration bars, using the breaking load specified for the different classes of castings.

In order that the results given in the accompanying tables may be readily compared, the following data are recapitulated from the standard specifications for gray iron castings of the American Society for Testing Materials.

These specifications state that castings having any section less than ½-inch thick shall be known as light castings; castings in which no sections less than 2 inches thick shall be known as heavy castings, medium castings being those not included in the foregoing classifications. A minimum of 0.08 per cent sulphur is specified for light castings; an increase to 0.10 per cent is permitted for medium castings and 0.12 per cent is allowed for heavy castings. The quality of

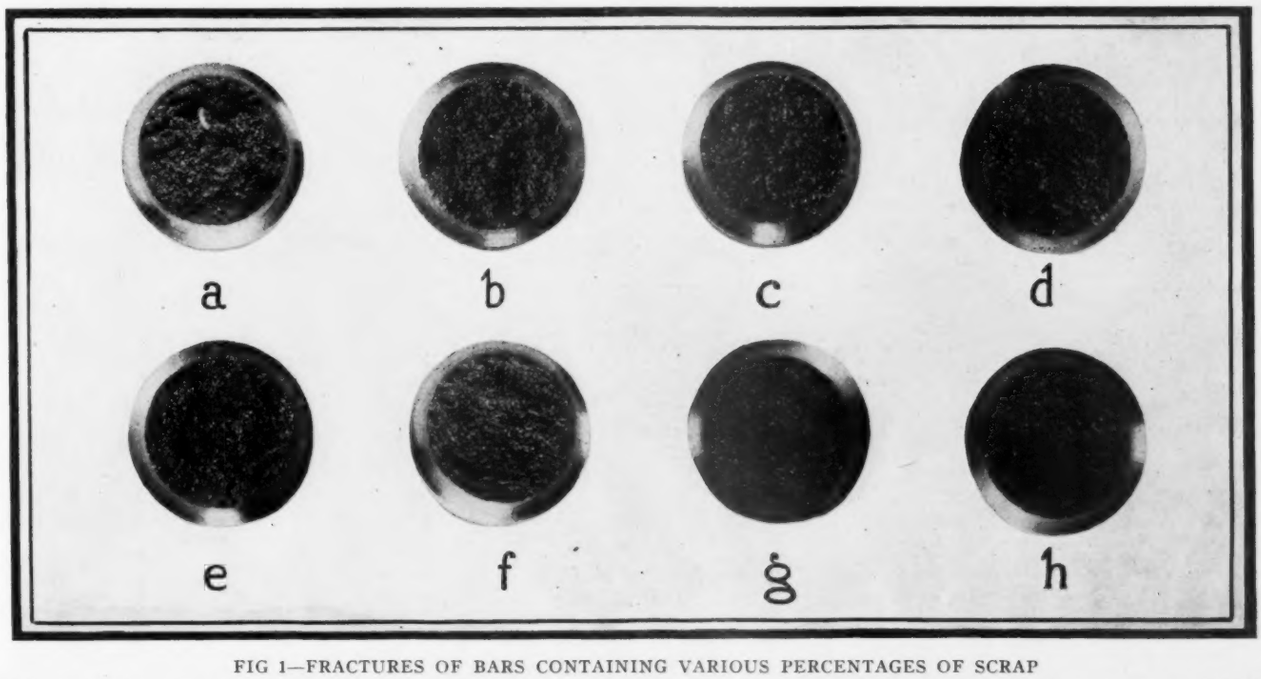


FIG 1—FRACTURES OF BARS CONTAINING VARIOUS PERCENTAGES OF SCRAP

(a) pure pig iron; (b) 20 per cent scrap; (c) 40 per cent scrap; (d) 50 per cent scrap; (e) 60 per cent scrap; (f) 80 per cent scrap; (g) 50 per cent scrap including 10 per cent steel; (h) 50 per cent scrap including 20 per cent steel

the iron going into the castings is determined by means of a test bar known as the arbitration bar. This is a bar 1¼ inches in diameter and 15 inches long. Two sets of two bars, it is specified, shall be cast from each heat, one set from the first and the other set from the last iron going into the casting. Each set of two bars is cast in a single mold. The bars are not rumbled or otherwise treated, being simply brushed off before testing. The transverse test is made on all bars cast, with supports 12 inches apart, the load being applied at the middle and the deflection at rupture noted. The minimum breaking strength of the arbitration bar under transverse load shall not be less than the following:

	Pounds.
Light castings	2,500
Medium castings	2,900
Heavy castings	3,300

In no case shall the deflection be less than 0.10-inch. The tensile strength of light castings shall not be less than 18,000 pounds per square inch; for medium castings it must be at least 21,000 pounds and for heavy castings at least 24,000 pounds per square inch. It is also specified that the castings shall be true to pattern, free from cracks, flaws or excessive shrinkage.

The following characteristics were made for each melt:

1.—Transverse strength, average of four specimens.

2.—Tensile strength, average of four specimens.

3.—Scleroscope tests for hardness, four specimens.

4. — Micro-structure examination, three specimens.

5.—Examination of fracture, one specimen.

6.—Deflection at breaking, 12-inch centers, four specimens.

7.—Shrinkage in green sand, average of two bars; also average of two bars with ends of mold stopped off with cast iron blocks to obtain shrinkage against a chill.

8.—Castings of different weights of section were machined to determine whether they were suitable for commercial purposes and also to determine the polishing qualities.

9.—Chemical analysis, average sample from each melt.

Table I.
SUMMARY OF TESTS ON VANADIUM CASTINGS.

Test No.	Per cent scrap in mixture.	Tensile strength, lbs. per sq. in.	Transverse strength bar 1½ x 12-in. Breaking load on 12-in. centers.	Modulus of rupture, lbs. per sq. in.	Deflection. in.	Shrinkage, in. per ft. In green sand.	Shrinkage, in. per ft. Against a chill.	Hardness shore scleroscope tool steel = 100.	Pouring Temperature, Fahr.
1	0	25,220	5,540	50,645	0.097	0.111	0.131	36.25	2,280
2	20	26,550	5,270	47,725	0.086	0.113	0.125	35.75	2,241
3	40	22,080	5,740	50,220	0.098	0.108	0.127	36.75	2,475
4	50	23,345	5,900	53,465	0.116	0.117	0.138	36.40	2,125
5	60	25,840	5,140	54,990	0.104	0.126	0.148	36.10	.....
6	80	24,500	6,130	54,695	0.114	0.120	0.148	35.50	2,145
7	*50	29,890	6,765	59,715	0.103	0.113	0.148	37.75	2,250
8	†50	30,515	5,720	56,680	0.071	0.235	0.240	46.75	2,220

*Includes 10 per cent steel scrap. †Includes 20 per cent steel scrap.

It will be noted that the tests tend to show that the pig iron has unusual scrap carrying abilities. Prof. Fitch's report contains certain suggestions regarding the employment of this iron for ordinary foundry purposes, portions of which are as follows:

"In making recommendations for mixtures for castings, it must be remembered that a mixture of this iron with a different scrap would give results which could not be compared with certainty with the results obtained in the tests. Nevertheless the latter must give a good notion of what a foundryman can expect from this iron with scrap mixtures which are not very different from those used in the tests. Bearing this in mind, I would recommended a 50:50 per cent mixture for all work except heavy castings. A mixture of 20 per cent pig and 60 per cent gray iron machinery scrap will give good medium castings and will also be suitable for heavy castings. In addition, a mixture of 80 per cent gray iron machinery scrap and 20 per cent pig iron will satisfy the requirements for heavy castings. The 60 per cent mixture had an average hardness of 36.1 and the 80 per cent mixture a hardness of 25.5. In one melt 60 per cent pig iron was used with 20 per cent return scrap, 20 per cent foreign gray iron machinery scrap and 10 per cent scrap machinery steel. This mixture appeared to be satisfactory for all classes of castings. They were easy to machine, being of close grain and soft and they took a high polish which was easy to obtain. A large increase in the average for both transverse and tensile strength was obtained. This iron appeared to be particularly suitable for cylinders for internal combustion engines."

It will be noted that the tests indicate that there is nothing to be gained from using mixtures containing large proportions of pig iron, even for automobile cylinders or other work requiring a soft, dense and machinable metal.

Foundrymen are constantly devising methods of cheapening their mixtures without impairing the quality. Prof. Fitch's tests would indicate that this end may be obtained by selecting the proper grade of pig iron and melting it with scrap of known composition in a properly controlled cupola.

An Answer to Slow Melting in the Cupola

By James H. Anderson

In the March issue of *The Foundry*, page 106, was published an article entitled "Slow Melting in the Cupola", written by C. Metcalf. The writer has had 30 years experience in foundry work and he would like to inquire why the suggestion is made to reduce the coke charge with the iron charge remaining the same as the heat progresses.

Table II.
ANALYSES OF MATERIALS.

	Pig iron, for all tests.	Scrap for Tests Nos. 1 to 6.	Scrap for Test No. 7, 10 per cent steel.	Scrap for Test No. 8, 20 per cent steel.
Silicon	2.00	1.74	1.69	1.13
Sulphur	0.02	0.09	0.07	0.06
Phosphorus	0.58	0.49	0.65	0.52
Manganese	0.69	0.36	0.49	0.38
Graphitic carbon	3.07	2.55	2.31	1.88
Combined carbon	0.55	0.75	0.38	0.37
Total carbon	3.62	3.30	2.69	2.25
Titanium	0.22	0.04	0.06	0.06
Vanadium	0.04	0.01	0.02	0.02

Table III.
ANALYSES OF MIXTURES.

	Test No. 1, pure pig iron.	Test No. 2, 20 per cent scrap.	Test No. 3, 40 per cent scrap.	Test No. 4, 50 per cent scrap.	Test No. 5, 60 per cent scrap.	Test No. 6, 80 per cent scrap.	Test No. 7, 10 per cent semi-steel.
Silicon	1.88	1.79	1.69	1.69	1.67	1.67	1.57
Sulphur	0.05	0.06	0.06	0.05	0.07	0.09	0.05
Phosphorus	0.72	0.70	0.59	0.64	0.62	0.62	0.64
Manganese	0.62	0.65	0.49	0.49	0.49	0.49	0.39
Graphitic carbon	3.03	3.03	2.85	2.83	2.65	2.66	2.58
Combined carbon	0.66	0.58	0.69	0.64	0.71	0.75	0.69
Total carbon	3.69	3.61	3.54	3.47	3.36	3.41	3.27
Titanium	0.16	0.16	0.12	0.91	0.09	0.06	0.19
Vanadium	0.41	0.04	0.02	0.02	0.02	0.01	0.02

FIG. 2—STRUCTURE OF BAR CONTAINING 40 PER CENT SCRAP

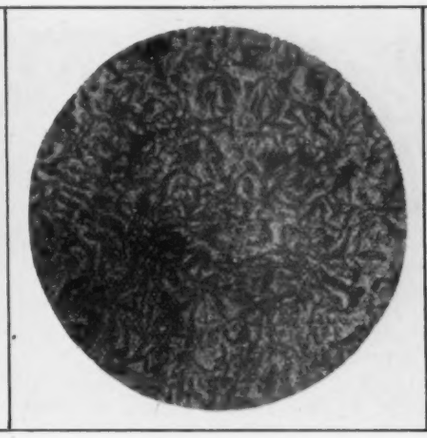


FIG. 3—STRUCTURE OF BAR CONTAINING 50 PER CENT SCRAP

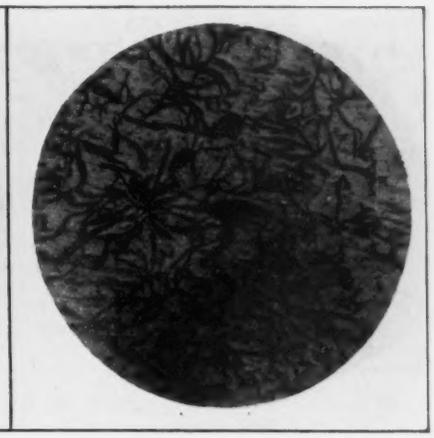


FIG. 4—STRUCTURE OF BAR CONTAINING 60 PER CENT SCRAP

The article refers to a 10-ton heat started in a 40-inch cupola with a charge of 1,000 pounds of iron on a bed extending to a height of 23 inches above the tuyeres, which was followed by 130 pounds of coke for four charges, four charges of 1,000 pounds of iron and 120 pounds of coke. This then was followed by eight charges of 1,000 pounds of iron and 100 pounds of coke and the remaining charges consisted of 1,000 pounds of iron and 80 pounds of coke. The writer is unable to fathom the reason for this method of procedure. The melting zone of any cupola is controlled by the size of the tuyeres and the volume of air delivered. In other words, tuyeres and blower conditions govern the melting zone.

As to the blast pressure, the writer cares nothing about it, as it is merely a relic of the past. Volume of air delivered in the cupola melts the iron and not blast pressure. First of all, the fan or blower that was delivering the air to this cupola was running at the same rate of speed and, consequently, was delivering the same amount of air to the cupola at the end of the heat as at the beginning. The size of the tuyeres are the same and consequently the melting zone was the same distance from the top of the tuyeres at the end of the heat as at the beginning.

The difference in the coke charges is 50 pounds, varying namely from 130 pounds at the beginning of the heat to 80 pounds at the end of the heat. This would carry the iron charge from 5 to 6 inches nearer the tuyeres at the end of the heat than at the beginning. It is stated in the article that the bed was 23 inches above the tuyeres at the beginning of the heat and, therefore, at the 17th charge it was 17 to 18 inches above the top of the tuyeres in place of 23 inches as at the beginning. The bed, therefore, was lowered gradually as the heat progressed. One of two things certainly was being done, either excess coke was being burned at the beginning of the heat or the cupola was delivering cold iron at the finish. It is the contention of the writer that if the last four charges were melted successfully at a height of 17 to 18 inches above the tuyeres, then the first 16 charges could have been melted just as successfully at the same point. For this reason the extra 50 pounds of coke charged to bring the heat up to 23 inches above the tuyeres was in excess of what was required. While it is difficult to guess the height of tuyeres from the sand bottom in the cupola referred to, it would seem that the bed consisted of 800 pounds of coke and there was used between the charges 1,990 pounds of coke, making a total of 2,790 pounds of coke burned to melt 10 tons of iron. This gives a melting ratio of 7 pounds of iron to about 1 pound of coke, which the writer considers high for a heat of this size.

However, if it requires 2,790 pounds of coke to melt 10 tons of iron in this cupola, the bed should not have extended more than 17 to 18 inches above the tuyeres at the beginning of the heat and the intervening charges for each charge of 1,000 pounds of iron should have been 110 pounds of coke. This method of procedure, we are certain, would insure successful melting and a uniform temperature throughout the heat. No hanging or bridging should be experienced providing the cupola is kept free from slag.

The Sprague Electric Works of the General Electric Co., New York City, has established a branch sales office in the Illuminating building, Cleveland, in charge of Frank H. Hill, who likewise is manager of the Pittsburgh office of this company.

FIG. 5—STRUCTURE OF BAR CONTAINING 80 PER CENT SCRAP

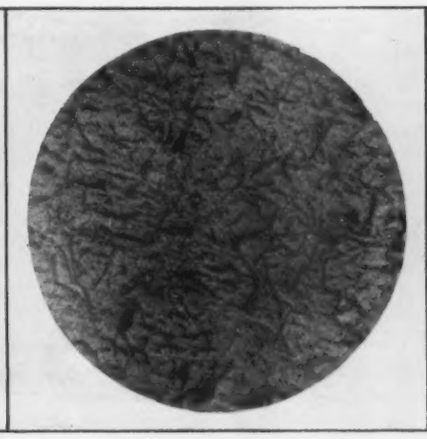


FIG. 6—STRUCTURE OF 10 PER CENT SEMI-STEEL BAR

FIG. 7—STRUCTURE OF 20 PER CENT SEMI-STEEL BAR

How to Operate the Sand-Blast Efficiently

Suggestions for the Cleaning Department, With Side Lights on Sand and the Wear of Sand-Blast Nozzles

By James M Betton

NO SAND BLAST can work efficiently without an ample supply of compressed air, carried at an even and steady pressure. The air must be dry and free from oil and moisture, which will otherwise condense on the sides of the sand tank, run down and cake the sand about the sand valve, besides especially in the case of oil, clogging the air pipes.

The quantity of compressed air consumed by any sand blast is only the amount that is delivered through the nozzle, barring leakage. The size of the air inlet to the sand blast does not modify this, the quantity of air used is that which finally issues from the nozzle mixed with the sand. This applies to any make of sand blast, without exception.

The horsepower required to compress 100 cubic feet of free air from atmosphere to the various pressures given below, with one-stage compression, is given in Table I.

No allowance is made for friction of air in compressor or piping, for which 15 to 20 per cent should be added.

To obtain the power required to supply any sand blast with compressed air under a given pressure, multiply the quantity of air, in cubic feet, discharged per minute from a nozzle of the diameter selected, under the stated pressure, by the actual horsepower required to compress 100 cubic feet of free air, as shown, and add 20 per cent for friction. This is worked out in Table II, which gives the quantity of air discharged through nozzles of various diameters under the usual limits of working pressures, 20 per cent being added for friction.

Table I.

Gage pressure, pounds.	Actual horsepower.	Gage pressure, pounds,	Actual horsepower.
2.....	0.93	55.....	12.67
5.....	1.96	60.....	13.41
10.....	3.60	70.....	14.72
15.....	5.03	75.....	15.37
20.....	6.28	80.....	15.94
25.....	7.42	85.....	16.50
30.....	8.47	90.....	17.06
35.....	9.42	100.....	18.15
40.....	10.30	125.....	21.00
45.....	11.14	150.....	24.00
50.....	11.90		

How the Sand Works

Regulate the flow of sand into the current of air so that just enough will issue from the nozzle to give a good cutting effect. The sand cleans an object by striking an infinite number of sharp blows on a small area, and not by the friction of the particles sweeping over it. Just enough sand will enable each grain to get in good work. Too much will cause the particles of sand to rub on one another and reduce their energy by the friction of their particles.

As a rule, hold the nozzle about 6 inches from the surface to be cleaned, at an angle of from 30 to 45 degrees therewith. Use coarse sand in preference to fine, for general cleaning. It does quicker work with less dust and breaks into smaller particles which can be used again. Dry all sand over a fire, either on an iron plate, stirring continuously, or in a sand-drying stove. Sand that contains any moisture cannot be depended upon to flow from the sand tank by gravity. Do not use sand that contains clay, loam or burnt sand, all of which cause unnecessary dust in the cleaning room. Clay and loam can be washed out of the original sand, if better cannot be procured, and burnt sand sifted out by a double-decked screen. All sand should be run through a No. 8 mesh screen before being placed in the sand tank. Stones, chips, shells, leaves and paper will surely clog the nozzle and interrupt the blast, unless they are removed.

Make the air piping between the air receiver and the sand blast as short and direct as possible. Do not reduce it below the size the air connection calls for and, if the distance is over 75 feet, make it at least one size larger. This reduces the friction of the air in the piping and gives a volume of air behind the sand blast. Keep the air piping tight and protect it from the cold if it is exposed, preventing condensation. If the air is damp when it reaches the sand tank, use a moisture separator near the tank, or trap out the moisture from the bottom of a U-shaped bend.

If a pressure-reducing valve is used to cut down the air pressure in the sand blast, put a small air receiver in the air line, between the reducing valve and the sand blast, to give a good body of air behind the blast, as well as to condense moisture. Keep the pressure reducing valve clean and free from pipe scale inside, to obtain best results.

The air compressor should be of sufficient capacity and power to supply freely the quantity of air discharged by the sand blast nozzle under the selected pressure, and to maintain this pressure evenly. When you have determined the quantity of air needed, buy a compressor of about double this quantity. The additional quantity will be very quickly utilized in your work and the first cost will not be unreasonably greater. You will not regret doing this. You cannot get the air receiver too large.

For large nozzles, ⅜-inch, ½-inch, ⅝-inch or ¾-inch diameter of bore, the air pressures of 20 to 40 pounds, use 1½-inch hose at least. For pressures 45 to 80 pounds use ¾-inch delivery hose and ¼-inch nozzle. This size hose is easier to handle, does not fatigue the operator as much as a larger size and the highest velocity of the mixed air and sand is maintained. Do not kink or bend the hose to shut off the sand. It destroys the hose very quickly, fills the tube with solid sand, which, with the power required to eject it, is wasted as far as working effect is concerned. If this were not the case, every sand blast would be provided with a shut-off valve at the nozzle end of the hose.

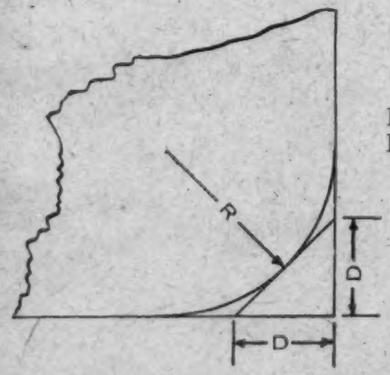
Nozzles

All nozzles will wear, some faster than others, and no nozzle has yet been made that will stand up to this severe work for any length of time. The material of which a nozzle is made makes very little difference in the rapidity of its wear. All wear too quickly. A short nozzle wears better usually than a long one in which the sand eddies from side to side, expending valuable energy in wearing out the containing tube.

As the nozzle wears, the consumption of air increases very rapidly, for which reason it is not good economy to continue to use a nozzle that is worn much beyond the original bore. Valuable power is easily wasted in this manner and a compressor

PATTERNMAKER'S TABLE FOR ROUNDING CORNERS

By S. L. Cook



R = Radius
D = Distance to be scribed from each corner, the corner is flattened down to these lines and the remaining small fins can be easily rounded over.

R	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16
D	1/32	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16	15/32
1	1/32	5/64	1/16	3/32	1/16	5/64	1/16	7/64	1/16	1/16	1/16	15/64	15/64	15/64	15/64
2	1/16		1/4		15/64		13/64		13/64		13/64		15/64		15/64
3	1/16		1/16		13/64		13/64		2 1/64		2 1/16		2 1/16		2 1/64
4	2 1/32		2 1/64		2 1/64		2 1/16		2 1/64		2 3/64		2 3/64		2 1/64
5	2 1/16		3		3 1/64		3 1/32		3 1/32		3 1/64		3 1/64		3 1/16
6	3 1/32				3 1/64				3 1/16				3 1/64		
7	4 1/64				4 1/4				4 1/32				4 1/32		
8	4 1/16				4 1/32				4 1/32				5 1/16		
9	5 1/32				5 1/64				5 1/16				5 1/32		
10	5 1/32														

USEFUL TABLES FOR PATTERNMAKERS

By S. L. Cook

Frequently pipe connections are made to castings and the patternmaker has to figure on cores of proper size to admit the pipe. The finished diameters of the cored holes for various sizes of pipe are given, with other information, in the pipe table below. The table of wood screw data shows the size drill to use in drilling patterns for screws of various sizes. The sizes of drills less than ¼-inch diameter are given in Brown & Sharpe wire gage numbers. The fillet table gives the principal dimensions of leather fillets.

WROUGHT IRON PIPE DATA

Size, inches	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
Actual external diam...	0.405	0.54	0.675	0.84	1.05	1.32	1.66	1.90	2.38
Actual internal diam...	0.27	0.364	0.494	0.623	0.824	1.05	1.38	1.61	2.07
No. of threads	27	18	18	14	14	11½	11½	11½	8
Size of tap drill. (Cored holes must be finished to this diameter)	21–64	29–64	11/32	37/64	23/32	1 7/16	1 11/16	1 31/32	2 7/16

Size, inches	2½	3	3½	4	4½	5	6	7	8
Actual external diam...	2.88	3.5	4	4.5	5	5.56	6.63	7.63	8.63
Actual internal diam...	2.47	3.07	3.54	4.03	4.51	5.04	6.07	7.023	7.982
No. of threads	8	8	8	8	8	8	8	8	8
Size of tap drill. (Cored holes must be finished to this diameter)	2 9/16	3 1/4	3 3/4	4 1/4	4 3/4	5 5/16	6 5/16	7 3/16	8 3/16

WOOD SCREW DATA

No. of screw	20	18	16	14	12	10	9	8	7	6	5	4	3	2
Drill for body	1/4	3/16	17/64	15/64	2	10	17	19	26	28	30	36	39	44
Drill for threads	15/64	1	6	12	19	23	26	29	33	37	41	44	47	50

DATA ON LEATHER FILLETS

No.	1	2	3	4	5	6	7	8	10	12	14	16
Size or radius	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
Width of face	3/16	1/4	5/16	3/8	1/2	5/8	11/16	3/4	11/16	1 1/16	1 3/16	1 5/16

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

closely calculated for given work may easily become overworked. Change the nozzle when its outlet becomes appreciably greater than the original bore and save the air. A cylindrical nozzle never wears at the point of entrance but always at the outlet end. A disc nozzle, on the contrary, wears on the inlet side and not at the outlet, hence the volume of air consumed always remains constant and the pressure steady.

Make the cleaning room as simple and as light as possible. Admit light from above when possible. Make the floor of steel sheets to retain the sand and have all walls tight and protected from the flying sand.

Make the dust outlet near the floor, in the wall opposite the door and connect to it an ample exhaust fan. The dust will then be drawn down and away from the worker's face and the fan suction may be increased to a point at which the dust is always kept away from him. Admit fresh air through door. Locate the cleaning room so that the castings may come to it in regular order. Save steps and time.

Put the sand blast in charge of an intelligent workman who understands the machine and elevate the work from a "job" to a department, giving due credit for prompt, quick and clean work. The sand blast is as important and useful a tool in the shop as a lathe, drill, planer, grinder or other machine tool and will save its cost when properly located and handled. The sand blast requires dry air under proper pressure and dry sand to give satisfactory results. The sand must flow from the sand tank. You cannot ram it through.

Straight or Boshed Cupola Lining

By W. J. Keep.

Question:—What is the advantage of drawing in the lining of cupolas around the melting zone? Is it not a fact that the charges in dropping down as the iron melts and the coke burns out become disarranged and do not settle as uniformly as they would, if the lining was straight all the way down? Also, in drawing in the lining, the amount of space provided for accumulating iron is smaller than if the cupola stack were straight. I have been unable to discover any advantages unless the cupola is exceedingly large, when the lining might be drawn in somewhat to direct the blast to the center. However, with cupolas 72 inches and smaller in diameter, I see no advantage of drawing in the lining.

Answer:—So far as melting is concerned, there is no difference between a straight and boshed lining. If you are doing good work, do not make any change. If you line straight a 72-inch cupola, the lining should be 9 inches thick, leaving 54 inches inside diameter. The melting capacity would be from 10 to 12 tons per hour. The lining above the tuyeres would cut out badly and if you melted 28 tons per day, you probably would have to reline twice a year at least half way to the charging door. If you make a bosh you could bring it to 49 inches, 9 inches above the top of the tuyeres, and the bosh should taper outward for 24 inches, leaving the inside diameter 62 inches to the charging door. Below the bosh the sides flare out to the tuyeres and the lining is straight below the tuyeres. The distance from the tuyeres to the sand bottom should be from 12 to 20 inches. With this arrangement the blast will reach the center of the cupola and will not burn out the lining as fast as if it were straight. The daubing will not fall off the sloping bosh as it will off a straight lining and the charges will settle more evenly. You do not draw in the lining, but flare it out and reduce its thickness to 5 inches above the bosh, instead of 9 inches. The boshed cupola will hold two or three more charges than the straight cupola and the iron, therefore, absorbs more waste heat. It does not pay to bosh a cupola if the diameter at the charging door is less than 48 inches. The bosh is best for cupolas when the iron is taken out as fast as it is melted. If you wish to use the cupola as a reservoir, the straight lining is best.

Table II.

CUBIC FEET OF FREE AIR DISCHARGED PER MINUTE BY SAND BLAST NOZZLES, WITH HORSEPOWER REQUIRED FOR OPERATION—20 PER CENT ADDED FOR FRICTION

Single Stage Compression at Sea Level

Diam. nozzle, inches.		Gage pressure, pounds. 2	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100	125
1/8	*	2.435	3.86	5.45	6.65	7.70	8.60	10.00	11.20	12.27	13.40	14.50	16.80	19.00	21.20	23.5	25.8	31.4
	†	0.026	0.09	0.24	0.40	0.58	0.77	1.02	1.26	1.51	1.79	2.06	2.70	3.35	4.06	4.8	5.61	7.9
3/16	*	5.45	8.72	12.30	15.00	17.10	19.40	22.40	25.00	27.40	30.40	32.80	37.50	42.90	47.50	52.4	58.0	70.0
	†	0.06	0.20	0.53	0.90	1.33	1.73	2.27	2.82	3.42	4.04	4.68	6.03	7.57	9.08	10.7	12.6	17.6
1/4	*	9.74	15.40	21.80	26.70	30.80	34.50	40.00	44.70	49.00	53.80	58.20	67.00	76.00	85.00	94.0	103.2	125.5
	†	0.11	0.36	0.94	1.60	2.32	3.07	4.05	5.05	6.05	7.19	8.31	10.77	13.40	16.26	19.2	22.5	31.6
5/16	*	16.18	24.12	34.00	41.75	48.25	54.00	63.00	70.00	76.75	84.00	91.00	105.00	119.00	132.50	147.0	161.0	196.0
	†	0.18	0.56	1.46	2.50	3.64	4.80	6.41	7.90	9.50	11.23	13.00	16.90	21.00	25.34	30.0	35.0	49.4
3/8	*	21.95	34.60	49.00	60.00	69.00	77.00	90.00	100.00	110.50	121.00	130.00	151.00	171.00	191.00	211.0	231.0	282.0
	†	0.24	0.81	2.11	3.62	5.20	6.90	9.14	11.30	13.65	16.20	18.60	24.30	30.00	36.50	43.2	50.0	71.0
1/2	*	39.00	61.60	87.00	107.00	123.00	138.00	161.00	179.00	196.40	215.00	232.00	268.00	304.00	340.00	376.0	412.0	502.0
	†	0.43	1.44	3.75	6.45	9.26	12.24	16.30	20.16	24.24	28.70	33.10	43.10	54.00	65.00	77.0	90.0	127.0
5/8	*	61.00	96.50	136.00	167.00	193.00	216.00	252.00	280.00	307.00	336.00	364.00	420.00	476.00	532.00	587.0	645.0	785.0
	†	0.68	2.27	5.87	10.00	14.54	19.20	25.61	31.70	37.90	44.90	52.00	68.10	84.00	101.70	120.0	140.0	198.0
3/4	*	87.60	133.00	196.00	240.00	277.00	310.00	362.00	400.00	441.80	482.00	522.00	604.00	685.00	765.00	843.0	925.0	1,127.0
	†	0.97	3.13	8.46	14.50	21.00	27.60	36.70	45.20	34.60	64.40	74.70	97.20	121.00	146.40	173.0	202.0	284.0
7/8	*	119.50	189.00	267.00	326.00	378.00	422.00	493.00	550.00	601.30	658.00	710.00	823.00	930.00	1,004.00	1,145.0	1,260.0	1,361.0
	†	1.33	4.44	11.53	19.67	28.50	37.60	50.00	62.10	75.50	89.00	101.40	132.00	164.00	192.00	234.0	274.0	343.0
1	*	156.00	247.00	350.00	427.00	494.00	550.00	645.00	715.00	785.40	860.00	930.00	1,070.00	1,215.00	1,360.00	1,500.0	1,648.0	2,000.0
	†	1.74	5.81	15.10	25.80	37.20	50.00	65.50	80.80	102.00	115.00	132.80	172.00	215.00	260.00	308.0	359.0	504.0

†Horsepower.
*Free air.

Slow Melting and Cupola Lining Burning-Out

By W. J. Keep

Question:—Our cupola bridges after the first three or four heats are melted and the tuyeres must be cleaned out constantly to permit the remaining charges to melt properly. Our furnace is lined to 30 inches and is equipped with six tuyeres, 9 x 4½ inches. In one heat of 10,000 pounds the lining burns out at the melting zone to a depth of 3 inches all around. Our blast pressure is 6½ ounces. The bed consists of 400 pounds of coke, which reaches a height of 30 inches above the tuyeres, and the subsequent charges consist of 850 pounds of iron and 125 pounds of coke. The cupola is lighted two hours before the blast is on. After the blast is on, iron is tapped in about 12 minutes. In each

charge is placed a chunk of iron weighing about 160 pounds and the charges throughout are made up principally of heavy machinery scrap. Our heats average five tons each and require about two hours to melt. After every two heats the melting zone requires relining.

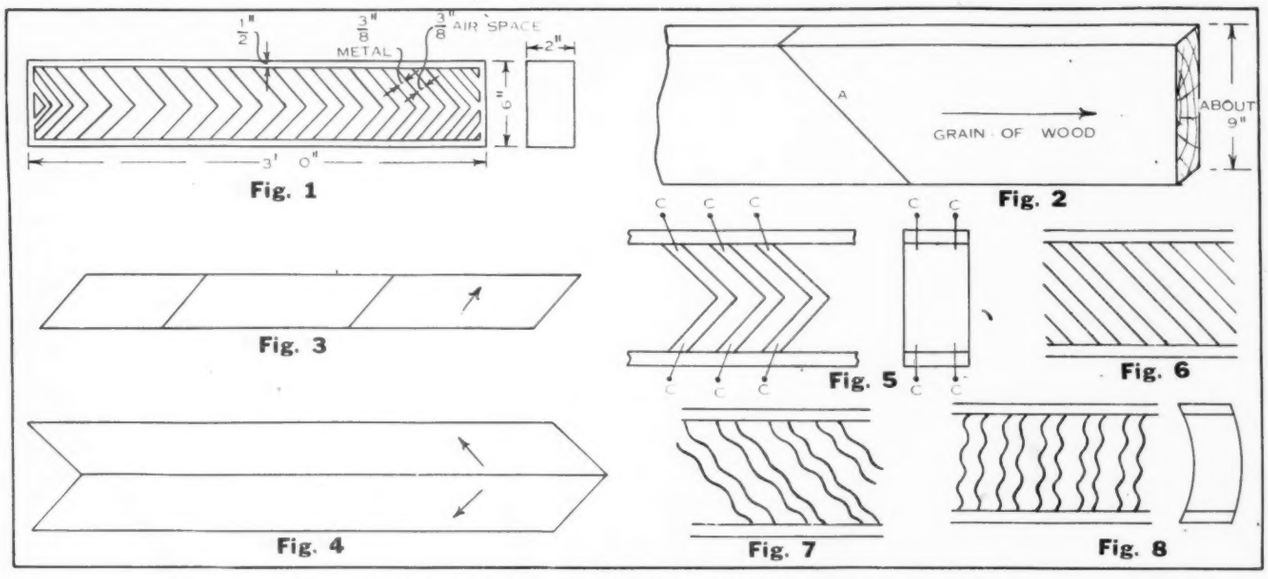
Answer:—Your melting ratio is 5.75 iron to 1 of coke, which is not so bad for a 30-inch cupola, and the effect on the lining might be expected. A scrap melt is hard on the lining. Your blast is so light that it goes up the sides of the cupola, but if the blast is much stronger it is likely to blow across and cut out the lining on the opposite side. You probably are using scrap iron from smelters which is very high in sulphur. The only way to melt well in a 30-inch cupola is to use no pieces of iron larger than 30 pounds. The rust on scrap gives trouble. Very likely, it is necessary to use as much coke as you have on the bed and other charges, but unfortunately burning so much coke will burn out the lining. Try to slag your cupola as soon as the slag will run. If you will look over your files of *The Foundry*, you will find very full instructions for slagging. You would in that way prevent the melted ash from reaching the lining at the melting zone. Do not use smelter scrap if you can get along without it. Under ordinary conditions your tuyeres are too large. I would never open the tuyere doors after beginning to melt. With your large tuyeres there will be plenty of room for air if you slag your cupola. The slag is in a foam above the top of the tuyeres and as soon as you open a door it drops down, freezes and causes the bridging. When the iron once starts, keep right on with the blast pressure. In slagging you want a hole that is so small that the blast will not blow out. Do not place the slag hole under a tuyere, but below the space between the tuyeres. If the slag is chilled by the blast, close a portion of the tuyere openings next to the slag hole. Use good limestone broken as small as a hen's egg.

Making a Herringbone Grate Pattern

By Edgar L Scillitoe

IN THE November, 1914, issue of *The Foundry*, J. L. Gard, describes a method of making a herringbone grate pattern. In this connection, the following alternative method may be of interest. Fig. 1 represents the pattern required. The first step is to select a good, clear piece of wood about 9 inches wide from a lumber rack and cut a piece off at the same angle as the bars as shown at *A*, Fig. 2. This piece is planed on the jointer to 2⅛ inches thick and is then cut into parallel strips on the circular saw, commencing at the face *A*. The strips are about 2¾ inches wide. After they are cut off they are glued together to form two strips, the full length of the pattern as indicated in Fig. 3. One face and one edge of each of these pieces is then planed true and square and a joint is formed and glued as shown at *B*, Fig. 4. While the glue is drying the sides are planed. The joint *B*, Fig. 4, now becomes the center line and the block is shaped exactly to the inside size of the outside frame of the pattern. The lower face of the block should then be shaped to whatever design is required. The bars now are laid out on the top of the block as shown in Fig. 1 and two nails are driven partly into each bar as indicated at *C*, Fig. 5. Each bar is numbered for position. The nails are withdrawn far enough to allow the block to become free; the frame is removed and the block is sawed up carefully with a sharp band saw at whatever bevel is necessary to give the required draft to the bars. The bars are next cleaned on a sand paper disc machine and are thoroughly coated with shellac except on the ends or where fillets are to be placed. After shellacing the bars are replaced in their proper position by the aid of the nail holes. With good glue and a little care an evenly spaced pattern is secured. Screws can be added to standard patterns and if the joints are made properly, the life of the pattern will be entirely satisfactory. This method is equally good for other types of grate bars, such as are shown in Figs. 6, 7 and 8. Varying air space adds no difficulty.

On the grates shown in Figs. 7 and 8, a sand paper roller can be used in a lathe to clean up the bars.



SKETCHES SHOWING PROCESS OF MAKING A HERRINGBONE GRATE PATTERN

Two-Story Foundry for Continuous Operations

Different Types of Plants Are Discussed in Which Cost of Production is Reduced and Many Economies Effected

By G K Hooper

THE two-story type of foundry is a natural development of the necessities attending the use of molding machinery. It has for some time been well understood that the molding machine requires much auxiliary apparatus for the development of its full capacity and efficiency.

The large capacity of molding machines naturally necessitates a large amount of floor space, which means handling large volumes of material, especially sand. Conveyors naturally suggest themselves for this work and these necessitate trenches in the floor into which sand can fall or be shovelled after shaking out, a conveyor at the bottom taking the sand to any desired point. It was soon discovered that to give these conveyors the necessary attention and care, the trenches must be increased in size, until finally the designer, in providing for a number of molding machines, found himself practically incurring the cost of a cellar without getting one, so that a cellar under the foundry floor became inevitably the next step. This step, however, was in a false direction, since naturally a cellar is dark and somewhat expensive to construct and incidental to its construction, floor space became available which could be put to good use, so that the suggested cellar became a ground story with the molding floor raised up above it and the two-story foundry was then complete as far as general plan is concerned.

Several Two-Story Types

A number of two-story foundries have been built and as previously stated, several types exist. Of these, but one seems likely to endure, that is, the one in which the shaken-out sand falls through the molding floor onto conveyors situated underneath the ceiling of the first story. In this case the floor space of the first story is used for cooling, cleaning and storage of castings with sometimes, coremaking and simple finishing operations on some or all of the castings, gravity being used to a great extent in handling castings, etc., from the molding to the first story floor. There are more of this type in existence than all of the other types put together and, in my opinion, it is the type which is destined to endure. It was also the first of the several types to come into existence, the others being variations of it.

The other types include those in which practically no conveying machinery is used beyond an elevator for sand at each molding station, the ground floor being entirely devoted to cooling, tempering and handling of sand. Much labor is necessary to properly condition the sand and deliver it to the elevators by which it is returned to the molding machines. It is contended that this labor is no more costly than the investment, power and maintenance charges of sand conveying machinery. I am sure that this is not the case, while the space occupied for a given tonnage is doubled and the casting loss increased, as the sand can never be as well conditioned by hand as by means of properly designed machinery. Comparatively few foundries of this type are in operation, and in my opinion, this form cannot endure as it is wasteful of space and labor when compared with the first type. Its design originated, I believe, in a mistaken idea of the disadvantages of conveying machinery.

The third type is a combination of the two foregoing in that not only is the lower floor used practically entirely for the storage and conditioning of sand, but much conveying machinery, in addition to the elevators, is used for this purpose, the whole forming a decidedly costly and wasteful method of conducting these operations. So far as I know, only one plant of this type has been built; its construction cost was undoubtedly great and its operating cost must be greater than either of the other two.

A slight advantage in mold handling is claimed for these two latter designs. Since two-story buildings cost in round numbers three times as much to build as one-story buildings of the same ground and type of construction, their floor space costs 50 per cent more than that of a one story building. This entails, of course, an additional overhead charge which would largely offset any advantage gained through a slight increase in labor efficiency.

Several two-story foundries of the first type have been built on the upper stories of the manufacturing plants which use their castings. Such a location makes no essential change in the construction or general arrangement and it does not necessarily follow that the same advantages of handling which exist in the two-story foundry are obtained by superimposing a number of finishing operations with the foundry above them.

The more that operations are superimposed the more complicated are the considerations of space, construction, handling and storage and I can state from direct information as to the comparative handling costs of a two-story foundry located on the ground and one placed on top of the finishing plant, both operating on the same product, that there is no gain in this respect in the superimposing of the foundry upon the rest of the plant. It is noticeable that a prominent concern now using several superimposed foundries is building its newest one on the ground, although of the two-story type.

Continuous Operation

All of the two-story foundries in existence are operated on the continuous system which is, of course, another logical consequence of the use of molding machinery with its attendant devices. The molding operations are conducted by a number of different methods. Sometimes the gang system is employed, short floors being utilized for placing the molds which are poured either by a pouring gang or by the mold maker. In the latter case, the iron is brought to the molder by a ladle gang, after which a shaking-out gang takes charge of the molds and separates sand, castings, equipment, etc. Another method of operation is continuously by means of a mold conveyor, no floors being used in this case. Sometimes the two methods are united in one building where the production will permit.

A general review of my records of the operation of two-story foundries indicates that the floor space required for molding, casting and shaking-out is somewhat less than one-third of that required for the same class of work in the one-story, one heat foundry.

Areas vary considerably with varying classes of work as will be evidenced by carefully compiled figures published by *The Foundry*, which show that in American practice a space of from 400

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to 850 square feet per ton, per day, is used in one-story foundries for differing classes of work. I have had a case in hand in which the relative area figured out almost exactly one-third of the present floor space and another where the change from a one-story building operating two heats per day to a two-story plant, operated continuously of course, made a reduction of 36 per cent in the floor space used. This practically confirms the one-third or, 33 1-3 per cent figure, as compared with operation at one heat, per day. The castings averaged 70 per cent of the melt.

If the cooling and cleaning operations should balance up in time and space with the molding, pouring and shaking-out, the best type of two-story foundry, exclusive of the raw material yard, could then be built on about one-third of the ground space occupied by a one-story, one heat plant.

This great reduction of area, of course, is not entirely available since in one story, one heat operation, cooling goes on at night thus consuming neither time nor space during the operations of the day, while the cleaning usually is spread over the entire working day and does not balance up relatively with the molding, casting and shaking-out. These features tend to increase the relative ground space to something higher than the previously noted percentage, but on the other hand, storage, simple finishing operations on part or all of the castings, and sometimes core making, can be united in the two-story plant thus effecting a saving in floor space elsewhere in the plant which should be credited to the two-story design.

It seems safe to state, therefore, that two-story foundries can be constructed for such work as lends itself properly to handling in this way, on from 120 to 200 square feet of ground per ton of castings per day, exclusive of storage of sand, metal and fuel.

General Construction

The buildings for the two-story foundry should be preferably of brick and steel construction with fireproof roof and floors. The wearing surface of the floors preferably should be of repressed shale brick.

The width of the building, if pouring and shaking-out are handled by separate gangs, will vary from 70 to 90 feet, depending upon the size of the mold, this providing a floor of suitable length on either side of a central bay, which is used for shaking-out and as a general passage for ladles, patterns, cores, etc. This arrangement will bring the molding machines or benches at the windows. If a mold conveyor is used, the building can be narrowed. The length of building bay along the wall should be about 16 feet, this gives plenty of room for floors for molds which must be handled by a light crane or an overhead monorail traveler and permits the doubling of snap floors, it being possible to put two of these in a bay 16 feet in width. The molding floor preferably should be free from columns, all overhead apparatus such as conveyors, cranes, monorails, carriers, etc., being supported on the roof trusses. Columns are not objectionable on the first floor. Their spacing should, however, be as great as suitable accommodation for the apparatus used there will permit. This spacing, however, will be largely predetermined by the width of the bay adopted for the molding and casting floor.

Roof Construction

A roof of considerable pitch, with large monitor, is suggested to insure ventilation and light. A live load of 275 pounds per square foot is sufficient for the molding and casting floor, except in the cupola bay where special supporting arrangements must be provided. Window area is made a maximum with maximum openings for ventilation. Such a building costs, in the vicinity of New York, about $2.60 per square foot of floor area.

The benefits gained by two-story foundry construction are those of continuous operation, since without handling machinery two-story construction would be unnecessary and with handling machinery continuous operation, by some method, is predicated that the increased overhead charges may be diminished to the greatest extent.

Another point of saving is in the investment in individual equipment; this diminishes in direct proportion with the reduction in number of operatives. The foundry loss also is diminished, being reduced in some instances to one-half the percentage of that shown by operation in which the molder pours his own molds. One-third less loss is, however, a more representative figure.

Briefly, the various advantages of the two-story foundry, therefore, are less ground space, higher labor efficiency, decreased foundry loss and reduction in total cost of molding equipment. The sum total of these, when applied to several differing lines of work, has made a favorable showing on the right side of the ledger.

Paxson Secures Zippler Tuyeres

The J. W. Paxson Co., Philadelphia, has been licensed as the exclusive manufacturer and distributor of the Zippler tuyerage system and has secured the services of the inventor, Francis J. Zippler, who will install and demonstrate this system of distributing the blast in cupolas.

Overcoming Slag and Dirt in Gray Iron

By P. R. Micks

The working conditions in every foundry are, of course, different and equipment that would prove beneficial to one would be useless in another. It is the foundryman's business to pick such equipment as he thinks will prove most useful for his work. A method for overcoming difficulties arising from poor iron has been of the greatest service to me and I am sure it will settle the question of slag and dirt to others.

In the accompanying illustration are shown plan, side and front views of a spout made of cast iron and lined with 2-inch fire brick which can be easily attached to any cupola. The melted iron passes out of the tapping hole, *A*, into the box *B*. The spout, *C*, is a trifle higher than the main spout, *D*, where the iron is caught and carried away. The slag, being lighter than iron, will stay on top of it and cannot pass the brick partition, *E*, while the clean iron will pass under it. The slag will pile up back of partition, *E*, and if kept hot by inserting a few pieces of wood, will flow out of the spout, *C*. This arrangement provides for the operation of two spouts.

From the one spout, clean, hot iron will be obtained as fast as it melts, and from the other, all the slag and dirt will be discharged. At the end of the heat when the bottom is dropped the hole, *F*, is tapped to drain the box. The lever, *G*, is then thrown up and the spout is swung to one side on the hinges, *H*, plan view. Two graphite sleeves are rammed up in the breast and a graphite stopper is used if trouble should arise; otherwise the iron runs continuously.

For such work as light machinery, ornamental castings or stove plate requiring high silicon and hot iron, this device is of great benefit owing to the fact that the iron is carried away as fast as it melts and is not exposed to the effects of the high temperature and blast in the cupola where a great deal of silicon would be lost.

For heavy machinery or heavy work of any nature I have my doubts as to its practicability, as the iron in the ladle would probably get too cold before a sufficient amount would be accumulated to pour. I have poured castings weighing two or three tons without trouble of this kind and I understood from some authorities that iron will stay hotter out of the cupola than in it. However, this device will operate to better advantage in small

shops pouring with hand or bull ladles.

The advantages of the spout may be summed up as follows:

1.—Cleaner iron.

2.—Melting capacity of the cupola increased. Slag is kept out of the cupola and away from the tuyeres.

3.—Melting time decreased in long heats.

4.—No plugging and tapping.

5.—No breast troubles.

6.—Avoids confusion.

7.—Insures a clean drop.

8.—High carbon can be carried which increases the life and heat of the metal without danger from slag.

9.—Low sulphur and high silicon can be obtained by keeping the furnace hot and well fluxed with limestone (50 or 80 pounds per ton of iron charged) which will send the silicon into the iron and the sulphur into the slag.

Although the principle of the spout is by no means new, having been used as a skimming gate on a mold for a great many years, few foundrymen have applied it to their cupolas.

Mixture for Chilled Crusher Rolls

By W. J. Keep

Question:—We have received an order for chilled crusher rolls averaging from 4 to 8 inches in thickness, which have to be chilled from 2 to 3 inches in depth. Our coke iron available consists of one lot containing silicon, 2.10 per cent; phosphorus, 0.84 per cent; manganese, 0.47 per cent, and sulphur, 0.048 per cent. The second lot analyzes silicon, 1.65 per cent; phosphorus, 0.54 per cent; manganese, 1.10 per cent, and sulphur, 0.02 per cent. We also have considerable steel rail scrap on hand. Our pig iron charges consist of 3,000 pounds each and we would be glad to have you advise us how to proceed in charging our cupola and in making the mixture to obtain the desired results.

Answer:—It is advisable to have your pig irons of as nearly the same composition as the desired casting as possible. When this is not practicable the mixture should be made carefully. However, in your vicinity you should be able to obtain the irons that you need and with the use of steel scrap you should be able to use your local coke grades. The following are the standard analyses for crusher jaws, chilled castings, etc., suggested in a paper presented before the American Foundrymen's Association:

Chilled castings: — Silicon, 0.75 to 1.25 per cent; phosphorus, 0.20 to 0.40 per cent; sulphur, 0.08 to 0.10 per cent; manganese, 0.80 to 1.20 per cent; combined carbon, 3 per cent, and total carbon, 3.20 per cent.

Crusher jaws:—Silicon, 0.80 to 1 per cent; phosphorus, 0.20 to 0.40 per cent; sulphur, 0.08 to 0.10 per cent; manganese, 0.80 to 1.20 per cent; combined carbon, 3 per cent.

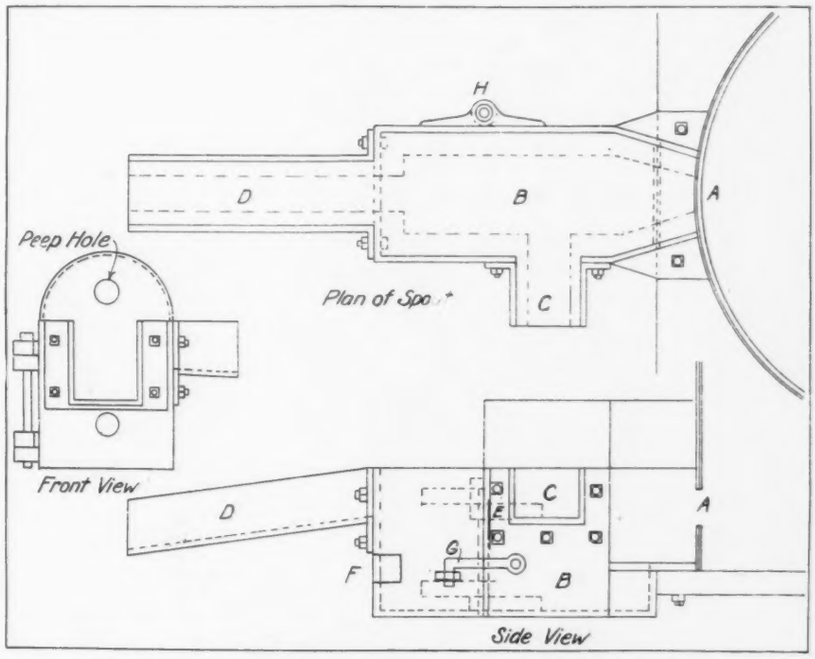
Car wheels: — Silicon, 0.60 to 0.70 per cent; phosphorus, 0.30 to 0.40 per cent; sulphur, 0.08 to 0.10 per cent; manganese, 0.50 to 0.60 per cent; combined carbon, 0.60 to 0.80 per cent, and total carbon, 3.50 to 3.70 per cent.

Chilled rolls: — Silicon, 0.60 to 0.80 per cent; phosphorus, 0.20 to 0.40 per cent; sulphur, 0.06 to 0.08 per cent; manganese, 1 to 1.20 per cent, and total carbon, 3 to 3.25 per cent.

Sand rolls:—Silicon, 0.75 per cent; phosphorus, 0.25 per cent; sulphur, 0.03 per cent; manganese, 0.66 per cent; combined carbon, 1.20 per cent, and total carbon, 4.10 per cent.

As both chill and sand rolls are subjected to high and varying temperatures when rolling, the sulphur should be as low as possible to prevent cracking. Car wheels are liable to be cracked by the heat generated by the brakes, but it is customary to have comparatively high sulphur to obtain the desired chill. Crusher jaws, of course, are not subjected to high temperatures and, therefore, a comparatively high sulphur mixture can be employed. Phosphorus in all of these mixtures should be low.

The depth of the chill should be regulated by the percentage of silicon and the steel scrap employed. An iron containing 0.80 per cent silicon would be a white grade. Hardness and toughness are imparted by the manganese and there is no danger of getting this too high. It is common practice to add spiegeleisen to the iron to obtain these properties. You will note that the mixture for crusher jaws is just what you desire and the total carbon is very low, which results from the low silicon and the fact that the iron is practically white. Get the pig iron mixture as nearly as you can to what you require for the No. 1 mixture and then calculate an addition of 20 per cent or less of steel scrap. However, you must use pig iron which with the steel scrap will reduce the silicon to at least 1 per cent. If this does not give you as deep a chill as you desire, reduce the silicon still further.



PLAN, SIDE AND FRONT VIEWS OF A SKIMMING SPOUT FOR ATTACHMENT TO CUPOLAS

Ann ealing Car Wheels

By W. J. Keep.

Question:—In car wheel work does the removal of the internal strains soften the iron? Is the removal of the internal strains equivalent to annealing? What is the best process to pursue to remove the internal strains in mine car wheels? Is annealing in pits the only way by which this can be accomplished? Do you think it possible to secure a good wheel and remove the internal strains by placing chilling molds around the hub of the wheel between the spokes of straight spoke wheels? Can internal strains, incident to the casting of mine car wheels, be removed sufficiently well for practical purposes in any manner other than in the soaking pit?

Answer:—The soaking pit is em-

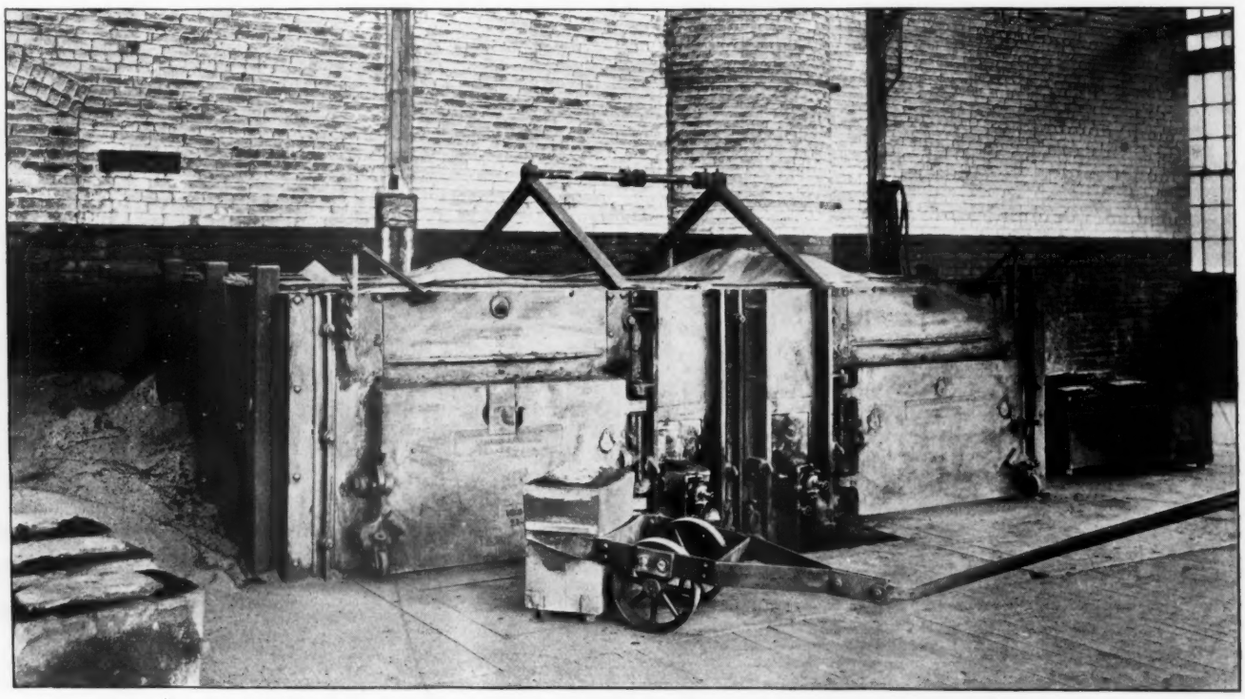
ployed for the purpose of insuring slower cooling, which softens the iron and removes the internal strains. This process is not similar to ordinary annealing, in which the casting is heated to within a few degrees of melting and then is slowly cooled. The wheel is cooled considerably before it reaches the pit and then does not get much hotter. All internal strains are removed by annealing and hard iron is made soft. The pit method is the only one in use, unless you cover the wheels with sand and cool slowly. The strains are due to the rapid cooling of the rims and chilling pieces around the hubs would increase the internal strains, but might balance them. The difficulty in casting straight spoke wheels is that the spokes shrink and cool while the hub and perhaps the rim is fluid or weak. By casting chunks between the spokes, the latter are made to cool as slowly as the other parts.

As a general proposition, a little more iron in the spokes and just sufficient in other parts will enable you to make good wheels without pitting. The chilling of the rims takes place almost instantly and the rim shrinks away from the chill. If your iron is low in silicon and phosphorus, the wheel will not touch the chill again.

Annealing Gray Iron Castings

CERTAIN manufacturers of builders' hardware have adopted the policy of annealing small gray iron castings in order to obtain a product with suitable properties. Cast iron lock cases for doors come in this class. Owing to the thin sections employed, the castings come out of the sand very hard and extremely brittle. The annealing reduces the brittleness, although it does not give the castings any of the qualities of malleable iron. The castings frequently are provided with small lugs which must be drilled or otherwise machined and it has been found that the annealing is necessary before these operations can be performed successfully.

The accompanying illustration shows an oil burning oven used by a large eastern manufacturer of builders' hardware for annealing work of this character. These ovens were furnished by the Brown & Sharpe Mfg. Co., Providence, R. I. They are of standard construction and are provided with an annealing chamber of suitable size to take a double row of pots. The castings are packed in the pots or saggers with sand. The pots are sealed on top and are heated to a dull red in the furnace for a period of from six to eight hours. As soon as the pots have been properly heated through they are pulled from the oven, but before they are dumped, are allowed to cool gradually for about a day. The illustration shows one of the pots or saggers together with the charging buggy. The annealing process apparently softens the castings through the precipitation of some of the combined carbon as graphite.



OIL-FIRED OVEN FOR ANNEALING GRAY IRON HARDWARE CASTINGS

The Chicago Pneumatic Tool Co., Chicago, announces that its New York office has been moved from 50 Church street, to 52 Vanderbilt avenue, and its Boston office from 191 High street to 185 Pleasant street.

Dixon Cupels

The Joseph Dixon Crucible Co., Jersey City, N. J., now is manufacturing cupels in three sizes, namely, 1¼, 1½ and 1¾ inches in diameter. These cupels are for use by refiners and assayers and it is claimed that the absorption of silver into the cupel is much less than with cupels made from bone ash when used under similar conditions. These cupels will not break in handling and are packed in lots of 100, 500 and 1,000.

The board of education, Toronto, Ont., is in the market for wood-working lathes, foundry, forge and machine shop equipment, and steel lockers for the new technical school. W. C. Wilkinson is secretary.

Controlling the Sulphur in Melting Pig Iron

A Combined Cupola and Open Hearth is Suggested for Melting Gray Iron to Reduce Sulphur to the Minimum

By W M Carr

IN THE February and March issues of *The Foundry*, Mr. Prince and Mr. Pitman make some observations on the behavior of sulphur in molten iron. In Mr. Prince's case it was found that if a jet of air be passed through a ladle of molten metal, subsequent analysis showed a lessened amount of sulphur. Mr. Pitman observed in castings condemned because of porosity in the cope, evidently induced by air being entrapped in the mold by the stream of metal, that the sulphur content was higher in the vicinity of the air cavities than in other parts of the castings.

Effect of Blast

In both cases, without an inquiry into the underlying causes for the loss or gain of sulphur, the inference was that there was some relation between air and sulphur. The first instance was an exemplification of the early experiments of Sir Henry Bessemer, the famous English metallurgist, who developed in the first half of last century the well-known bessemer or pneumatic process of steel-making. In his first attempts, he noted the effects of a blast of air in a forced draft furnace upon molten pig iron. The temperature was considerably raised and numerous marked changes had taken place in the composition of the charge. So what happened in Mr. Prince's tests was, first, that the temperature of the metal was increased by the jet of air and, second, the elevation of temperature, facilitated the separation and flotation of sulphur to the surface as manganese sulphide when it mingled with the slag. Not that there was any reaction chemically between the air introduced and the sulphur in the pig metal, but simply a promotion of liquation by gravity of a lighter body (sulphide) from the heavier (iron) and consequently a subsequent analysis of the iron would instantly show a lower content of sulphur over that previously existing.

In Mr. Pitman's notations the question of a higher sulphur in spots can be explained through a somewhat similar condition. It does not appear that the operation of pouring molten metal into a mold would increase the amount of sulphur in it by contact with or by locking into the casting portions of air. The source of sulphur must be sought apart from mold pouring. The segregation was clearly due to the previously mentioned causes, that is, liquation taking place in the ladle, and even in some cases the casting itself before freezing. What happened possibly was that the defective castings were poured from the first portion of a ladle where the sulphur would be higher than in lower parts, the metal more or less aerated and very naturally that first portion would form the cope of the castings. It is quite probable that an appreciable interval had elapsed between the filling of the ladle and the discharge entailing the phenomena under discussion.

It is well-known in progressive foundry circles that sulphur is one of the common enemies of successful practice and that the time is coming when the problem must be faced and its solution reached. The constant increment of sulphur through remelting of shop scrap is a grim fact.

A little reflection and deductive reasoning from the observations of the previously mentioned writers should suggest the conclusion that if sulphur will separate in a ladle of metal, if held long enough without a sacrifice of temperature, would not the separation of sulphur be promoted if means were provided to preserve and prolong the fluidity of the metal? It is lucidly evident that segregation of sulphur in molten iron will take place under three distinct and well substantiated conditions.

First, if manganese is present in sufficient quantity to unite with the sulphur and form a fusible compound. Second, if enough time is permitted to elapse to permit the flotation of the compound, and third, the preservation during that interval of a suitable casting temperature. The two latter conditions are the essentials to study with reference to the subject under consideration. The first condition comes within the radius of the limitation of the cupola, the others apart and beyond its functions.

Open Hearth for Gray Iron

In my paper presented to the American Foundrymen's convention held in Chicago, October, 1913, some suggestions were made relative to the advantages of an open hearth furnace as a melting medium for gray iron and possessing favorable points not permissible with a cupola. Concerning the subject of sulphur, it was pointed out that in melting with an open hearth furnace, the contamination of the bath by sulphur is practically negligible and this is an important feature to bear in mind. The open hearth was not advanced as an immediate successor to the cupola nor is such the case at this time. It was only recommended as an aid in cases where a cupola must fail in the event of more rigid specifications becoming necessary for gray iron castings. A cupola, notwithstanding, has two factors that cannot be discounted; first, that as a means of rapidly melting charges of iron it cannot be outclassed; second, the melting operation is cheap where coke is cheap. But it is still far from the ideal in other particulars that must be taken into account if we are to advance in foundry metallurgy.

Now the open hearth, while approaching nearer the desirable as a melting unit, it must be admitted, on the other hand, is very slow as a melting medium. On the other hand, as a refining medium and permitting thorough control of the bath or molten charge, it leaves little or nothing to be desired. Herein the cupola fails.

Combined Cupola and Open Hearth

Since my paper was published, Dr. Richard Moldenke has suggested a combination of the cupola and open hearth. As the cupola is a most persistent sulphurizing agent by reason of its fuel and the open hearth not producing the same objectionable deleterious effect, the plan of utilizing the advantages of both devices certainly points to a way out of the maze introduced by sulphur absorption under existing melting methods.

The details of the various possible combinations of a cupola and open hearth are matters of separate study governed by conditions in individual cases, that is to say the open hearth may be of my portable type, it may be tilting or stationary. However, the metallurgical advantages are equal in all types, so for the present the adaptability of the proposal will be considered mainly in that aspect:

Essentially the method would be to have at least two open hearth furnaces whose combined capacity would equal that of the cupola already installed.

They should be at a good heat before the cupola is ready to tap its first metal, which would be immediate y transferred to an open hearth whose function it will be to hold the charge at, or if desired raise it above the cupola tapping temperature. Then by the addition of ferro-manganese or other suitable manipulations, the removal of sulphur by liquation could be carried on as far as possible preparatory to subsequent casting operations. While the first portion of the cupola metal was thus being treated and nearing the point of tapping, the second open hearth would treat another lot of cupola metal. In the meantime, the first furnace would have delivered its portion to the casting floor and would be in readiness to receive another lot of cupola metal. This cycle of operation would be repeated, throughout the entire heat.

Rapid Melting in Cupola

If the cupola is charged with pig iron only and if this is rapidly melted, the amount of sulphur given up by the coke to the molten iron would not be excessive, but well within reasonable working limits. It is known that the length of time that the molten metal is retained within the cupola hearth directly affects the absorption of sulphur so that the more rapidly the iron is melted and tapped out of the cupola the less will be the gain in that element. It is also known that the depth of the hearth has a direct bearing on the absorption, hence the acceleration of melting and the shallowness of the hearth are favorable points to consider. By this method it should be possible to melt with less coke than under ordinary conditions, because no special attention need be given to the tapping temperature since that feature would be subject to subsequent open hearth control.

Melting Return Scrap

When the time comes to dispose of return scrap produced by this method, instead of putting it through the cupola it could be charged into the open hearth and mixed with cupola melted pig metal. This would effectually eliminate one step in cupola practice that is now a decided objection. That is to say, the return scrap always absorbs its share of sulphur in passing through the cupola and while there may be no way of knowing how often the return scrap may have passed through a particular cupola, it is certain that with each passage there was a gain of sulphur, so that with successive remelts of mixed charges of scrap and pig iron the gain goes on in a constantly increasing increment until the castings exhibit the characteristics of excessive sulphur. It has been pointed out that the absorption of sulphur in the open hearth is practically negligible, so that the matter of handling return scrap becomes a simpler one under the proposed plan than in existing practice.

Advantages of Open Hearth

In addition to the problem of bringing the control of sulphur within harmless influence there are a few more points in favor of an open hearth that may be appropriately noted. Charged with a bath of treated cupola metal it is quite possible to sample it and examine it by rapid chemical tests or visual examination of a fractured test plug to determine whether or not the charge conforms to a given composition. If desired, the silicon content can be raised or lowered. The total carbon can be reduced by boiling or by dilution with steel scrap. The graphitic carbon will be broken up into practically an amorphous formation and will render the metal more dense and closer-grained than with the coarse, plate-like structure in cupola castings. These advantages serve to support the essence of the proposal since they are wholly absent in cupola practice.

In conclusion the matter can be thus summarized:

1.—The removal of sulphur and its deleterious effects is much needed in gray iron practice.

2.—The use of a cupola adds to the difficulty. Does nothing in the direction of amelioration.

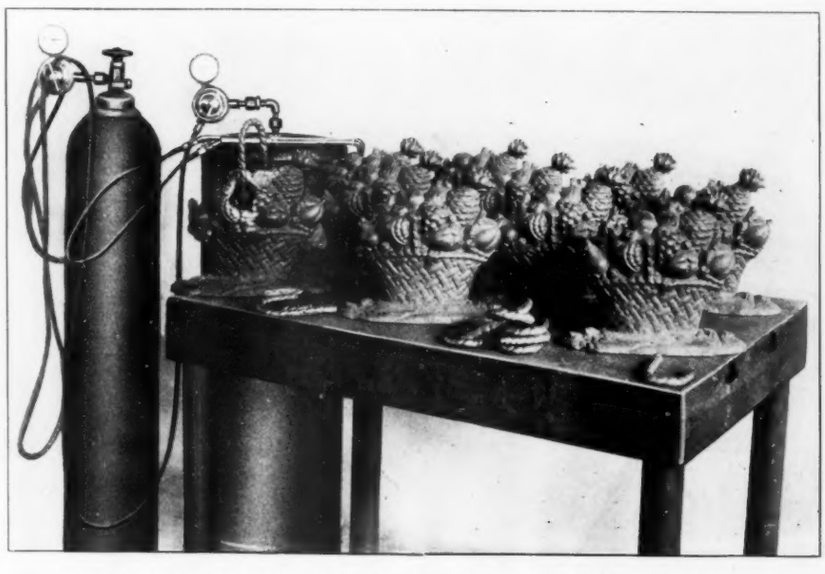
3.—The cupola is a most rapid melting device, but is negative in so far as acting as a reservoir or container of molten metal.

4.—The open hearth can hold a charge of molten iron almost indefinitely with no harmful absorption of sulphur though it will yield, under such conditions, to the slag portions of sulphur previously present in the raw materials, but as a melting unit only it operates at a much slower rate than the cupola.

5.—Then in the combination of clause 3 and 4, the weakness of one device being supplemented by the strength of the other, approaches what is sought, namely, the removal of the sulphur.

A Novel Welding Operation

IN THE accompanying illustration is shown a novel application of an oxy - acetylene welding and cutting outfit manufactured by the Dyer Apparatus Co., Cambridge, Mass. It will be noted that the ornamental cast iron baskets of fruit are made in two parts, consisting of the handles and the filled baskets. To cast the baskets with the handles would have involved an exceedingly intricate casting job and the work is greatly simplified by casting the handles separately and subsequently welding them to the baskets. The handles are welded to these baskets in about six minutes at a total cost of approximately 12½ cents for the time and material used. This is only one of the many applications of a welding outfit in foundry operations and undoubtedly many otherwise intricate castings can be produced more cheaply by casting them in several parts and welding the parts together.



INTERESTING APPLICATION OF WELDING APPARATUS IN FOUNDRY WORK. THE HANDLES ARE WELDED TO THE ORNAMENTAL CAST IRON BASKETS

THE BRASS FOUNDRY

Reclaiming Brass Foundry Waste

By A W Lemme

THE subject of reclaiming brass foundry waste is a large and vital one. Consider for instance the position of the firm with which the writer is connected, the Chicago Bearing Metal Co., Chicago, Ill. With a melting capacity of 100,000 pounds of non-ferrous metal per day, using two cars of coke a week, one car of fuel oil every 10 days, and about 80,000 pounds of molding sand a month, refuse accumulates at the rate of 12,000 to 15,000 pounds a day, and in accordance with the Illinois occupational disease act, the floors cannot be swept during working hours. Therefore, it is necessary to perform this duty at night and inasmuch as unskilled labor is employed, it has been found economical to dump the refuse in a pile in the back yard and pick out the largest pieces of metal by hand. The remainder of the sweepings are then riddled through a large screen which has a 1-inch mesh and that portion which passes through the screen is put through a crusher which is operated by a 35-horsepower motor.

The crusher rolls are about 4 feet in diameter with a 10-inch face, weighing approximately 6,000 pounds each. They run in a pan 18 inches deep and 10 feet in diameter. The pan is installed with the rim flush with the floor level so that the crusher may be loaded with a minimum of effort. The sweepings are fed into the pan gradually for 30 minutes, after which the crusher is stopped and the heavy brass is shoveled out of the pan and into a jig. The jig box is 14 inches square, the bottom being fitted with 100-mesh brass screen. Water is passed through the screen and the brass is thoroughly cleaned. The clean metal is shoveled out of the jig and the iron which it contains is picked out by hand. The product of the jig, which is termed *washings*, is used directly in some of the foundry mixtures.

The water which passes through the jig carries with it fine particles of brass. It is therefore led into a pit where it joins the overflow from the crusher pan and a sand pump is utilized to convey the settlings to a concentrating table. The jig, sand pump and table are belt driven by a 5-horsepower motor.

FIG. 1—THE REFUSE AND SWEEPINGS ARE FIRST PICKED OVER AND SCREENED BY HAND, THE WORKMAN WEARING A RESPIRATOR FOR PROTECTION AGAINST DUST

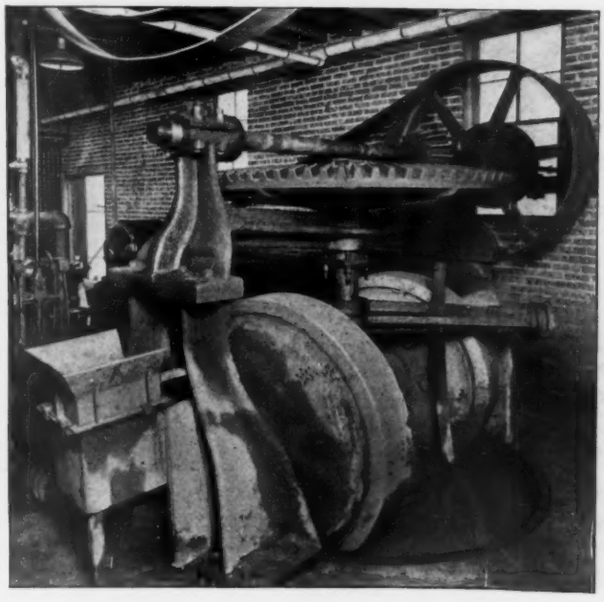


FIG. 2—CLAY MILL IN WHICH SCREENED REFUSE IS GROUND—AT *A* IS BOX CONTAINING 100-MESH SCREEN THROUGH WHICH PRODUCT OF MILL IS SIFTED

Four different kinds of metal are reclaimed, as follows:

1.—The large pieces of metal separated by hand.
2.—The washings.
3.—The pieces that are too large to go through a 1-inch mesh.
4.—The concentrate recovered by the concentrating table.

The first two separations are used directly in the foundry; the third is refined in a cupola and the concentrate, which contains about 20 per cent metal, is briquetted. The briquettes consists of 90 per cent concentrate and 10 per

A paper read at the April meeting of the Chicago Foundrymen's Club. The author, A. W. Lemme, is associated with the Chicago Bearing Metal Co., Chicago.

cent cheap stucco. The latter costs about $5 per ton in carload lots. The briquettes are formed by adding enough water to the mixture of concentrate and stucco to make a paste which is shoveled into forms, in which it sets quickly. Two men at 20 cents per hour make 300 briquettes in a 10-hour day.

To control the efficiency of the concentrating table, the tailings are analyzed. It is found that they contain an average of 0.85 per cent copper, the total metal content being 1.10 per cent. The tailings are analyzed every 24 hours. The washings contain about 85 per cent metal which analyzes approximately as follows: 77 per cent copper, 12 per cent lead, 7 per cent tin and 4 per cent zinc and impurities. The washings also are analyzed daily.

The material obtained from the third pressure of 12 or 14 ounces gives the best results in melting. The water in the jacket is maintained at a temperature of about 100 degrees Fahr.

Details of Charge

The charges are made up as follows:

	Pounds.
Limestone	50
Briquettes	240
Refuse	380
Slag direct from cupola	100
Coke	100
	Buckets.
Water	2

The cupola is given about five charges per hour. The slag is tapped out three times per hour and is maintained at a consistency of cream. It is not allowed at any time to become sticky, as it is absolutely necessary to keep it thin enough to permit the metal to flow through it freely. Otherwise a large proportion of the metal would be carried off with the slag. Slag is tapped into buggies similar to those used by copper smelters. The buggies are set aside to permit the slag to solidify after which it is dumped out on the ground. Each chunk of slag is broken open and inspected for metal.

The slag is sampled by using a small babbitt ladle. The samples are taken every hour, the slag being poured into cold water. The slag also is analyzed, one analysis being made to each 12 samples. The average slag analysis is as follows: Copper, 0.97 per cent; silicon dioxide, 43.5 per cent and iron 22.6 per cent.

The metal usually is tapped from the cupola twice every three hours, from which are cast eight to 12 ingots weighing about 25 pounds each. The ingots are drilled and the drillings are carefully analyzed. The average analysis of the cupola metal is as follows:

	Per cent.
Copper	82.00
Tin	8.00
Lead	7.50
Zinc and impurities	2.50

The cupola has been run as long as 12 days and 13 nights without interruption. Great care must be taken in charging.

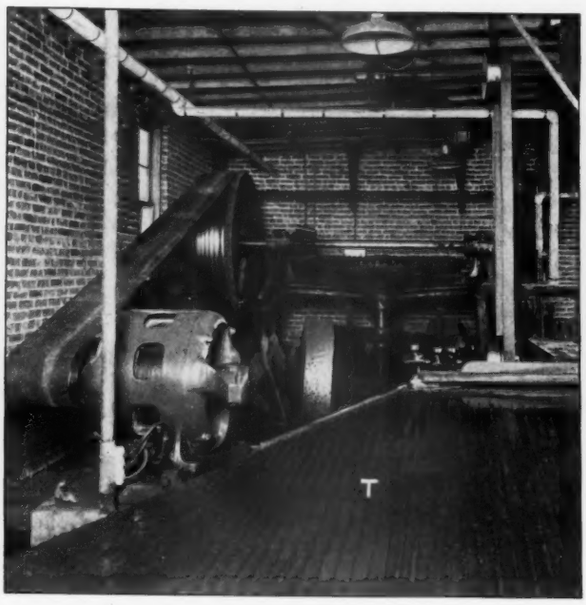


FIG. 3—CONCENTRATING TABLE *T* WITH GRINDING MILL IN BACKGROUND

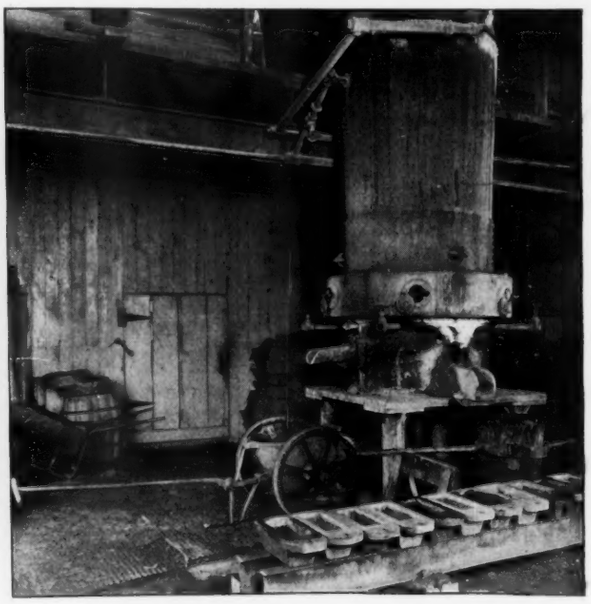


FIG. 4—CUPOLA FOR RECLAIMING REFUSE METAL, SHOWING SLAG BUGGY AT LEFT

and fourth separations is treated in a 24-inch, water-jacketed cupola. The tuyeres are 18 inches above the sand bottom and the slag notch is 6 inches above the tap hole. The lower portion of the cupola, between the bottom and the tuyeres, is cylindrical, 24 inches in diameter.

Between the tuyeres and the charging door, the diameter increases to 38 inches, the vertical distance between these two points being 10 feet. The cylindrical portion, between the bottom and the tuyeres, is lined with brick and the conical portion, between the tuyeres and the charging door, is surrounded with a 4-inch water jacket. The blast is furnished by a 6-foot Connellsville positive pressure blower driven by a 7½-horsepower motor. Various pressures have been tried, ranging from eight to 16 ounces and it has been found that a

Britannia Metal

Britannia metal is an alloy composed of copper, tin and antimony in varying proportions, and some of the mixtures do not materially differ from genuine babbitt, except in the proportion of copper. Britannia is used extensively in the manufacture of silver-plated

BRITANNIA METAL MIXTURES

Tin, per cent.	Antimony, per cent.	Copper, per cent.	Zinc, per cent.	Bismuth, per cent.	Lead, per cent.
72.00	24.00	4.00	0.0	0.0	0.0
81.90	16.25	1.84	0.0	0.0	0.0
85.5	9.7	1.8	3.0	0.0	0.0
89.3	7.00	1.8	0.0	0.0	1.8
84.00	9.00	2.00	5.0	0.0	0.0
88.50	7.00	3.5	0.0	1.0	0.0
90.00	6.00	2.0	0.5	0.0	1.5
90.00	7.00	3.0	0.0	0.0	0.0
90.00	5.00	1.00	0.0	0.0	0.0
85.50	5.00	3.50	1.5	0.0	0.0
80.00	10.00	3.00	1.0	0.0	6.0
90.00	10.00	0.0	0.0	0.0	0.0

ware, and reaches the scrap stage as No. 1 pewter. As the average amount of tin in Britannia metal may be placed at 90 per cent, the scrap is in considerable demand by brass founders as a cheap source of tin. For the ordinary mixtures of red brass, No. 1 pewter is quite satisfactory, as the small percentage of antimony does not unfavorably affect the quality of the brass. Some of the mixtures of Britannia metal in use are given in the accompanying table.

While the color of Britannia metal is white it is almost invariably silver-plated. Zinc increases the hardness of the alloy, and for that reason the copper is frequently added in the form of yellow brass. The alloy is made in much the same manner as babbitt metals, by first melting the copper in a crucible with a percentage of tin or antimony to form a hardening, which is afterward added to the balance of the mixture.

Annual Meeting of British Institute of Metals

AT the annual meeting of the British Institute of Metals, held in London March 18 and 19, the proceedings were confined strictly to the reading and discussion of papers, the usual dinner and other social features being omitted on account of the war. Three sessions were held, one on Thursday, March 18, and two on Friday, March 19, with Vice Admiral Sir H. J. Oram, engineer-in-chief of the English navy, presiding. On account of the situation in Europe, the number of papers presented was materially reduced, as compared with former meetings, but the proceedings nevertheless were full of interest and value.

Dr. G. H. Gulliver presented a third and final part of his investigation of the effect of rapid cooling upon the constitution of binary alloys. This paper was concerned chiefly with ordinary rates of cooling, those which are neither very rapid nor very slow. The general method of dealing with the problem was outlined, and detailed results for certain lead-tin and copper-tin alloys were given by means of diagrams. Comparison between some experimental determinations of the proportion of eutectic in alloys cooled at moderate rates and the corresponding calculated quantities of eutectic showed fair agreement. The quantitative effect of the rate of cooling upon the proportions of the phases in the case of a transformation was examined, together with the change of energy which accompanies such transformation.

The first two parts of a paper on "The Constitution of the Alloys of Copper with Tin" was presented by J. L. Haughton. In Part I the work of the earlier investigators of these alloys is reviewed, the main divergences in their diagrams being classified, and the need for an investigation of the points of difference is pointed out. In Part II the constitution of the alloys in the neighborhood of 60 per cent tin is investigated both by the microscopic examination of chilled and annealed specimens and by thermal curves taken from similarly treated specimens. The alloys were cast in a wedge-shaped sheet-copper mold immersed in a freezing mixture, and samples from the thin toe of the wedge were annealed for various periods at various temperatures in a thermostat-controlled furnace. The specimens were then polished and examined microscopically. The results of this examination agree with the thermal curve data in showing that there is no area on the constitutional diagram consisting only of pure epsilon, but that it exists along a line bounding the eta plus epsilon and the epsilon plus tin fields, as indicated by Heycock and Neville, though the position of that line is somewhat different in the present paper from that given by these investigators. The reasons for this difference are discussed at length in the end of the paper.

A paper was read by O. F. Hudson, on "Etching Reagents and Their Application." The object of this paper is to give a description of the principal reagents used in determining the microscopic structure of metals and alloys, giving the composition of the reagents, the methods of applying them and the purposes for which they are most suitable. The first part of the paper deals generally with the preparation of the specimen in order to bring it to a condition suitable for etching. The different etching reagents and methods of developing the structure are then described in some detail, and a summary is given containing a list of metals and alloys and the etching reagents suitable for them. Chief prominence is given to the etching reagents used for non-ferrous metals and alloys.

An interesting paper entitled "The Properties of Some Nickel - Aluminum and Copper-Nickel-Aluminum Alloys" was presented by A. A. Read and R. H. Graves. After a number of preliminary tests had been made, the mechanical and physical properties of a series of nickel-aluminum alloys and of copper-nickel-aluminum alloys with 1, 2, and 4 per cent copper were examined. The influence of nickel on aluminum bears considerable resemblance to that of copper in that it increases the yield point and tensile strength with the simultaneous diminution of elongation and reduction of area; it also increases specific gravity, hardness and rate of corrosion in both fresh and sea water, and decreases electrical conductivity and resistance to alternating stress. The present work dealing with alloys containing up to 5½ per cent nickel provides data for the following comparison between the effects of nickel and of copper on aluminum:

1.—The effect on the microstructure is similar.

2.—Specific gravities are equal for the same amounts of copper or nickel.

3.—Increase in the yield point and tensile strength of rolled rods due to nickel is not so great as that produced by an equal quantity of copper, though the elongations are the same in both cases.

4.—In the case of chill castings, the elongation of the nickel alloy is higher than that of the corresponding copper alloy, while there is practically no difference in tensile strength.

5.—Malleability (hot and cold) is reduced more by copper than by nickel.

6.—Ductility as measured by wire drawing is less for nickel-aluminum than for the alloy with an equal amount of copper.

7.—Nickel-aluminum alloys have a high resistance to alternating stress.

8.—In the case both of nickel and of copper alloys, the quenched material is almost identical in properties with the annealed.

9.—The mechanical properties of copper-aluminum alloys reach a maximum at about 4 per cent copper. A similar maximum had not been reached at 5½ per cent nickel.

10.—Corrosion of nickel-aluminum alloys both in fresh and sea water is less than that of copper-aluminum alloys.

The presence of copper and nickel together in aluminum leads to the formation of a triple eutectic, and the resulting alloys bear some resemblance to copper-aluminum alloys whose percentage of copper is equal to the total percentage of copper and nickel. None of the ternary alloys examined in the form of rolled rods showed as high a tensile strength as the 4 per cent copper-aluminum, while in the cast state, the replacement of more than 2 per cent of nickel by copper is of no advantage. This proportion of copper also gives the best elongation in chill castings. As in the case of nickel-aluminum alloys, the quenched material shows the same properties as the annealed. For any series of alloys in which the proportions of

nickel and copper vary while their total percentage remains the same, the following phenomena are observed:

1.—The specific gravities are constant.

2.—The more malleable alloys are those in which nickel predominates, the binary nickel-aluminum alloy being the most malleable.

3.—The more ductile alloys are those in which copper predominates, the binary copper-aluminum alloy being the most ductile.

4.—The elongation of the hot rolled material is independent of the relative proportion of copper and nickel.

5.—The corrosion was found to be least when only nickel is present, and was the greatest for the ternary alloys.

The following papers also were presented: "Some Experiments on Copper-Aluminum Alloys," by J. H. Andrew; "Some Appliances for Metallographic Research," by W. Rosenhain; "The Micro-Chemistry of Corrosion," by S. Whyte and "The Effects of Heat and Work on the Mechanical Properties of Metals," by A. K. Huntington.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Casting Bronze Sleeves

Kindly let me know the best method for casting bronze sleeves, 16 inches outside diameter, 29 inches long and ⅝-inch thick. The sleeves weigh approximately 225 pounds. We are now casting them in dry sand.

The best method of making castings usually is the easiest way. This, of course, is reduced to a problem of equipment and experience. For example, in a foundry accustomed to handling heavy work such castings would be considered small and they would be made in green sand without much difficulty. On the other hand, a foundry unaccustomed to such work probably would experience considerable trouble before good castings could be obtained. In the latter case the sand probably would be too close and it would be necessary either to skin-dry or bake the molds. This would necessitate the use of a facing on the molds that would not turn to dust upon the application of heat. Such a facing should be of a porous nature and to obtain this an admixture of lake or silica sand is required. To hold it together some kind of a bond is necessary similar to the one used in making cores and to obtain smooth castings a plumbago wash should be applied. The castings referred to preferably should be poured from the bottom and the metal should be cast from two crucibles or the gates should be so arranged that the metal will enter the mold from two sides. Agitate the metal as little as possible. If the metal has to run very far in two directions, namely horizontally and vertically, the chances for occluded gases and consequent porous castings are increased. Sometimes the metal is rained in from the top of the mold by a perforated cope or it is permitted to trickle down the sides of the mold in many streams fed by a gate encircling the mold. All of these methods have been productive of good results, nevertheless considerable chance is involved. All things considered, the best method by which the metal should enter such a mold is from the bottom through a number of circular holes in the center of the thickness of the casting so that the metal will neither strike the core nor the sides of the mold, but will bubble up through small, perpendicular, circular gates. In this way there will be no horizontal flow, but a steady rise of the metal vertically. The air will be forced out by the steady advance of the metal and the chances for obtaining sound castings will be materially increased. If the castings were made of aluminum bronze, such a method of gating would be imperative, otherwise the castings would be valueless.

Copper-Aluminum Alloys

In what proportions can we add copper to aluminum so that it will have practically the same color as brass, and can still be considered a good, strong alloy?

It is necessary to turn to the other end of the series of copper-aluminum alloys to obtain a metal that resembles brass. Copper and aluminum unite in all proportions to form a series of brittle alloys and when the aluminum predominates, 8 per cent copper is about as high as it is judicious to go unless a harder and more brittle alloy is desired. This alloy has a bluish white color. All of the alloys of copper and aluminum are white and brittle up to 17 per cent aluminum and 83 per cent copper. The alloys of a golden color begin below 17 per cent aluminum. The best of these alloys contains 10 per cent aluminum and 90 per cent copper, which is the formula for the well-known aluminum bronze.

How to Get Clean Metal

We have experienced considerable difficulty in getting our brass castings clean and solid. We have done everything possible to remedy the difficulty but do not seem to be able to rid ourselves of the uncertainty of the castings coming porous. We have been using scrap copper wire and block tin with our scrap which usually consists of old valves and an occasional scrap car brass. We tried the formula given on page 113 of The Foundry for March and although the alloy was very good for hardness, the castings were still porous, and we noticed that the zinc sputtered badly when it was added. The castings are mostly bushings, check valves, guides, etc., and although we dried some of the molds the difficulty still persisted.

The difficulty can be traced to the method of melting the copper. If the furnace is very large and the pot comparatively small, skillful melting will be required to avoid undue oxidation of the copper which will cause the trouble described. In preparing for a melt, place the crucible in the center of the furnace, coke it, and during the entire melt see that the crucible sets on an even keel. After the pot is coked, place in the bottom, half of an old dry battery, pounded up with an equal amount of powdered charcoal and anthracite coal. On top of this flux place the scrap brass constituting the charge to be melted and on top of the brass sufficient charcoal to cover it when it is melted. Close the furnace and melt the brass and get it sufficiently hot for the zinc to smoke. Now add a portion of the scrap copper wire, pushing it under the surface of the molten brass, and do not put in enough copper to chill the brass, but only as much as it will take and still remain fluid. Then allow the furnace to run awhile, until the metal is again hot enough to melt more copper and

continue this until all the copper is melted. Allow the metal to regain its heat again, then add the zinc, then the tin and finally the lead. Stir thoroughly and as soon as hot enough remove the crucible and pour the molds. The dry battery is used as a deoxidizer. The best deoxidizer for alloys of copper, tin, zinc and lead is manganese, but the percentage of manganese to be used is extremely low; the dry battery contains oxide of manganese, enough of which is reduced to metal by the charcoal to act as a deoxidizer of the brass. The addition of copper is made as outlined to avoid oxidation and the result ought to be sound castings. In place of the dry battery, 0.5 per cent of a 15 per cent phosphor-copper may be used; it should be added to the mixture just after the brass is melted and before the copper is put in the crucible.

Scratch-Brushing Yellow Brass

We are manufacturing yellow brass castings, containing a small percentage of aluminum, and we would like to have you advise us how they can be dipped to remove the aluminum color and give the castings a red color. Can you recommend a satisfactory flux for cleaning yellow brass in the crucible?

Scratch brushing greatly improves the appearance of castings containing aluminum, but if neither a rotary scratch brush nor a sand blast is available, the following dip may be tried: Sulphuric acid, 10 pounds; saltpeter, 2 pounds, and water, 5 pounds. Dissolve the saltpeter in the water and add the sulphuric acid very gradually. The solution should be made in an earthen crock and the sulphuric acid should be added from a pitcher pouring a very thin stream. The solution will get very hot and it should be allowed to cool before it is used.

Old dry batteries make a good flux for yellow brass in the proportion of one battery per hundred pounds of metal.

Aluminum Mixtures for Match-Plates

Kindly furnish us with formula for match-plates, which will be strong and tough and will not shrink more than ⅛-inch per foot.

The following formulas afford a choice for your work:

Aluminum, 92 per cent; copper, 6 per cent and tin, 2 per cent.

Aluminum, 88 per cent; zinc, 10 per cent and bismuth, 2 per cent.

Aluminum, 93 per cent; copper, 5 per cent; bismuth, 1 per cent and tin, 1 per cent.

Use of Brass Tube Scrap

We have in stock a large amount of brass tube scrap, copper, 70 per cent and zinc, 30 per cent, which we would like to utilize in various bronze mixtures. Kindly let us know to what extent we can use this scrap for making locomotive journal brasses, boiler check valves, bronze for polishing, hydraulic cylinders, blast furnace tuyeres and ordinary gun metal.

The following mixtures are suggested, which involve the use of your yellow brass scrap:

For journal brasses: Copper, 55 pounds; yellow brass, 30 pounds; lead, 10 pounds and tin, 5 pounds.

For boiler check valves: Copper, 60 pounds; yellow brass, 30 pounds; tin, 6 pounds and lead, 4 pounds.

For polishing bronze, gun metal, etc.: Copper, 71.5 pounds; yellow brass, 20 pounds; tin, 5.5 pounds and lead, 3 pounds.

For hydraulic cylinders: Copper, 75 pounds; yellow brass, 15 pounds and tin, 10 pounds.

For blast furnace tuyeres: Copper, 85 pounds and yellow brass, 15 pounds.

For ordinary brass: Yellow brass, 96 pounds; tin, 2 pounds and lead, 2 pounds.

Converted into metric weights, these mixtures, for instance in the case of journal brasses, would be as follows: Copper, 5,500 grams; yellow brass, 3,000 grams; lead, 1,000 grams and tin, 500 grams; total 10 kilograms.

Recovery of Aluminum Turnings and Borings

We have several barrels of aluminum turnings and borings and would like to know the best method of converting this material into pig form. We understand that under certain conditions of melting a considerable loss of aluminum results.

The melting of finely divided metals entails considerable work and furthermore, the material must be handled in a manner which will prevent undue oxidation. The best way to accomplish this is to dissolve the finer metal in a bath of molten metal. A large crucible should be used and the molten metal should be obtained by melting ingots or other bulky stock. In the case of aluminum, the bath should be raised to a temperature not above red heat. Charge as many borings at a time as the bath will dissolve, but do not leave any of the borings on top of the bath in a solid state. These should be stirred into the molten metal. Inasmuch as the bath increases with each charge of borings, it will dissolve more each time that additions are made. As the borings will cool the bath, the furnace should be closed from time to time, the metal again heated to redness, when more borings can be added, and this process can be continued alternately until the pot is full. At this stage the metal is cast into ingots, but sufficient should be left in the pot to form another bath. If the mush-like dross gathers on the surface of the metal, add a small piece of fused zinc chloride and stir it on the surface. This will liberate the metal from the dross, which will form a cover for the aluminum. The metal should be skimmed before casting into ingots. Incidentally, this dross is of no value.

In doing this work the borings should be passed through a magnetic separator to remove the iron and under no conditions should the bath of molten metal be heated above redness at any time, as otherwise the aluminum will attack the silica in the crucible and the metal will contain black specks.

Recovering Babbitt Metal

We have accumulated a large lot of bearing boxes containing babbitt metal which we would like to melt out and use in our new babbitt mixtures. Can you tell us how this can be done economically?

If the boxes are large, we suggest building a charcoal fire in a salamander or other convenient receptacle and invert the boxes over the fire, permitting the babbitt to flow through the fire and collect underneath. If the boxes are small, have the babbitt kettle half full of metal and charge the boxes, permitting the metal to remain until all of the babbitt has run out. When removing the boxes do so individually, striking them on the edge of the kettle to free them from all drops of white metal. If no babbitt kettle is available, the same method can be pursued by the use of a crucible, but in this case it will be necessary to exercise care to prevent the babbitt from becoming too hot. Otherwise the brass will be dissolved and will then enter into solution with the babbitt metal.

Use of Brass Turnings

We make a line of brass castings which are subjected to a water pressure of about 300 pounds. In our shop a large amount of brass turnings accumulates, which we add to our new metal, and we are anxious to have this material as clean as possible. After running these brass turnings through a magnetic separator we find that small particles of iron are still mixed with them and we would like to know whether any method has been devised for removing the last traces of iron from the brass.

Removing the last traces of any impurity in a metal is always difficult of

accomplishment and in the case of brass it is rare that an alloy is found that does not contain some traces of iron. We would suggest that the turnings be passed through a separator a second time, as it is difficult to remove all of the iron with the first operation. If the separator is in good operating condition, the amount of iron remaining in the turnings after they have been passed through the machine twice should not be sufficient to injure the brass made therefrom. We believe that it is not the iron that is causing your difficulty, but the oxygen incident to remelting the turnings and we suggest the addition of 0.25 per cent of the 15 per cent phosphor-copper to the turnings when they are melted.

High Tensile Aluminum Bronze

Kindly furnish us with a mixture for aluminum bronze which must have a high tensile strength. This bronze is to be used for castings subjected to a severe abrasive action and good wearing qualities therefore are desired.

The following alloy will fill the requirements stated: Copper, 89.50 per cent and aluminum, 10.50 per cent. The tensile strength of this alloy will average 65,000 pounds per square inch and the elongation may range from 9 to 20 per cent. according to the manner in which the alloy is made and the sectional area of the casting. In making the bronze, the most convenient method of preventing undue oxidation of copper is to melt this metal under a cover of fine charcoal. When the copper is molten and appears fluid, the aluminum is added by dropping it on top of the charcoal where it is melted before being stirred into the copper. Manganese chloride used in the proportion of 1 per cent is an excellent flux for this bronze.

Cores for Brass Castings

We would like a mixture for cores for small brass castings. We are using raw linseed oil as a binder, but the metal seems to burn into the core. The castings are ⅛-inch thick. Also furnish us with a red brass mixture that will run freely and machine easily.

For small cores the following mixture will be found satisfactory: Sharp sand (either lake or silica), 30 pound; molding sand, 10 pounds and powdered rosin, 2 pounds. Mix thoroughly in the dry state, moisten to the proper consistency to make cores and bake at a temperature sufficiently high to thoroughly melt the rosin. This makes strong cores.

The following alloy machines and runs freely: Copper, 85 per cent; zinc, 10 per cert; tin, 2 per cent and lead, 3 per cent.

Mixtures for Cores

Kindly furnish us with inexpensive mixtures for cores from ⅜ to 2 inches in diameter, which will vent freely. Also give us a mixture for facing sand that will insure clean castings weighing from several pounds to 100 *pounds.*

Free-venting qualities are obtained by the use of a sand high in silica and low in alumina, such sand being known as silica sand or sharp sand. Sand such as is used for building purposes makes a good core sand provided it is freed from grit and pebbles. A good bond for such sand for making stock cores is flour, the proportions of flour to sand being in a ratio of one to ten. If the cores have to be handled before being dried, it is necessary to mix molding sand with the sharp sand to give it strength. Linseed oil is an excellent binder for cores, a good proportion being one part oil by weight to 32 parts of sand (dry) by weight. Powdered rosin also makes a good core sand binder, a typical mixture being sharp sand, 30 pounds; molding sand, 10 pounds, and powdered rosin, 2 pounds. Mix thoroughly, add water to the sand until of the correct dampness for forming the cores and bake in an oven at a temperature of about 350 degrees Fahr. until the rosin melts and binds the sand together. The English Mansfield sands when well milled require no binder when used for cores such as those mentioned and the same sands mixed with 50 per cent Doncaster and milled with a little loam makes an excellent facing for brass castings.

Hard Copper Alloy

What mixture would you advise for a copper anvil and copper hammer, having about 26 scleroscope hardness?

A scleroscope hardness of 26 is equivalent to about 88 Brinell. This hardness cannot be obtained with less than 11 per cent tin, and even then the alloy will require phosphorus in addition to the tin; therefore, it is improbable that a copper anvil and hammer can be made of 26 scleroscope hardness. We suggest an alloy of 89 per cent copper; 10 per cent tin, and 1 per cent phosphor-tin.

Mixture for Plaques

We have been using babbit metal in casting small plaques and have finished them with a vere-antique lacquer to represent old brass and bronze. Is there any alloy that will melt at about 800 *degrees Fahr., copper omitted, which will give the effect of imitation bronze or brass?*

There is no alloy with as low a melting point as mentioned in your question that has the appearance of bronze or brass. An alloy of lead, 80 per cent; tin, 10 per cent and antimony, 10 per cent, is frequently used for casting soft metal plaques and trays. In order to obtain a brass or bronze finish the articles usually are given a deposit of copper as a foundation for the particular finish desired.

Soldering Aluminum Bronze

Kindly furnish us directions for soldering aluminum bronze.

For the purpose of soldering aluminum bronze, Brannt recommends that the parts to be joined should be cleansed of grease and dirt and then should be placed in a strong solution of copper sulphate. While in this bath an iron rod should be placed in contact with the parts to be joined until a deposit of copper has formed thereon. The parts then are removed from the solution of copper sulphate, are rinsed in clean water, after which the surfaces are brightened and tinned by the use of zinc chloride. Ordinary half-and-half solder is used to join the parts, but the tinning generally is accomplished with pure tin.

Brass Castings for High Pressures

We are experiencing some difficulty in making castings for a valve which must withstand a pressure of 10,000 *pounds. Our mixture consists of copper,* 82 *per cent; tin,* 8 *per cent; lead,* 5 *per cent and zinc,* 5 *per cent. We are using a large head and do not remove the castings from the sand until they are cold. If you can give us some information as to how we can obtain hard castings, your courtesy will be appreciated.*

Harder castings can be obtained by increasing the percentage of tin in the mixture, but this will be no guarantee that the castings will withstand the pressure to which they are subjected as increased hardness does not always mean increased density. Increased density can only be obtained by rapid cooling of an alloy from the molten state. Therefore, if you can make these castings in an iron instead of a sand mold the leakage difficulty will be overcome. While the foregoing suggestion is made in good faith, the use of iron molds for brass is attended with considerable difficulty, in view of which we suggest the use of chills at the places where the castings have been found to be most liable to leak. While the mixture is an excellent one we are inclined to think that the lead is somewhat high for pressure work and would suggest that it be cut in two and the copper increased in proportion, or the following mixture could be used: Copper, 86 per cent; tin, 10 per cent; zinc, 2 per cent and lead, 2 per cent.

Copper Cyanide Plating Solutions

By Dr. Max S Weber

THREE things are necessary for the deposition of metal: Current, electrode and electrolyte, or plating solutions As the plating solution is the most important, I will confine myself to this item. The object for employing cyanide solutions for the deposition of copper is to be sought in the fact that in such solutions iron does not replace copper, notwithstanding their places in the electrolytic series, a phenomenon which is due to the complexity of the salt in which the copper is present. The complex salt, which makes this feasible, is the double cyanide of sodium copper cyanide, the anion of which is Na, the cathion $CuCy_2$; that is by the action of the electric current, Na travels toward the cathode, $CuCy_2$ toward the anode. In other words, copper is not present in an ionized stage. Under proper current conditions, in other words, not too high current density and a suitable concentration of the solution, Na is not discharged at the cathode, but reacts with an undissociated part of $NaCuCy_2$, as per the following equation:

$$Na + NaCuCy_2 = Cu + 2\ NaCy,$$

thus showing that the deposition of copper is a secondary reaction, and that free cyanide is formed. On the anode, the anion $CuCy_2$ combine with the copper of the electrode, forming cuprous cyanide $CuCy_2 + Cu = 2\ CuCy$.

Cuprous Cyanide

Cuprous cyanide is insoluble in water, but soluble in cyanide solution, and for this purpose the free cyanide generated at the cathode is required. Supposing we have proper conditions —low current density on both electrodes—enough free cyanide is produced on the cathode in order to keep in solution the cuprous cyanide formed on the anode. As the free cyanide of the cathode is really needed on the anode for dissolving purposes, and as in a still solution the mixing velocity is very slow, stirring and warming of the electrolytic bath would expedite this matter considerably and bring the bath very near to an ideal stage. However, warm and agitated solutions require a more careful observation, on account of which these two items have not as yet been given the attention they actually deserve.

If a too high current density is used on the cathode, not all the Na ions act reducing on the sodium copper cyanide, but are partly discharged, forming sodium hydrate and hydrogen in connection with the water of the bath:

$$Na + H_2O = NaOH + H.$$

This reaction accounts for the development of hydrogen or gasing at the cathode. It means that less copper is deposited per current unit and not sufficient free cyanide formed in order to keep the anode clean. Therefore, the solution necessitated the addition of sodium cyanide, otherwise the anode becomes coated and the passage of the current is interrupted. A too high current density on the anode leads to the same result; covering of the electrode with an insulating film of cupri-cupro cyanide.

In regard to current density, it must be borne in mind that warmed and agitated solutions can be worked with a higher current density than cold ones, and that a density of approximately 30 amperes per square foot is quite feasible without yielding a burned and blistered deposit.

Another feature which is quite interesting is the amount of metal deposited per ampere hour. In a copper cyanide solution which contains the metal in the cuprous stage, the same amount of current should yield twice as much metal as in an acid bath, providing, of course, all the favorable conditions are prevailing, in other words, a strong solution, warmed and agitated, worked on nearly the contrary conditions, the relative amount obtained from a cyanide bath is much lower. How much lower depends entirely on the relative conditions. A low current density results in a high percentage of the metal deposited per electrical unit, while the deposition is slow. A high current density yields a lower percentage proportionately, but consuming less time for a certain amount of metal deposited, resulting in a greater deposition of metal per time unit.

Furthermore, cyanide solutions yield a finer, more homogeneous texture and brighter metal film than the acid baths on account of the secondary copper deposition and because hydrogen may develop more freely on the cathode in such a solution without fear of burning or blistering the deposit.

These few remarks give an idea how complicated the reactions in a plating solution are, and that it requires skill and experience to procure a satisfactory deposit.

The Double Salt

The first part of this paper has shown that the constituent which is essential in a copper cyanide bath is the double salt, sodium copper cyanide, consisting of copper cyanide and sodium cyanide, which is easily formed by adding the necessary amounts of each chemical to water. A high grade sodium cyanide has been obtained for quite a number of years, but copper cyanide could only be produced at prices which made its use prohibitive

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for technical purposes. For this reason many salts—one might call them subterfuges—have been used, which were intended to substitute copper cyanide and form the same when brought together with cyanide solution. One should bear in mind that whatever copper salt is brought together with cyanide solution, the final compound is the double salt, sodium copper cyanide. Another fact which should not be lost sight of, is that one chemical can replace another only to the extent of the requisite elements, and that by the reaction of two such salts, always a by-product is formed which contaminates the compound desired. This is the case with the copper cyanide. Copper carbonate, copper sulphate, copper acetate, cupri-cupro sulphite have been employed in order to form copper cyanide in connection with sodium cyanide and water. That by these reactions an inert by-product consisting of sodium sulphate or sodium sulphite or sodium acetate or sodium carbonate is formed to a high percentage, everyone was aware of, but took it for granted, as the product necessary was not obtainable commercially.

When using copper carbonate, which is really basic copper sulphate containing a small percentage of carbonate, according to the temperature at which it is precipitated, approximately one-half pound of inert matter is formed for every pound of copper carbonate, being composed of sulphates and carbonates. By the use of copper acetate, or cupri-cupro sulphite this inert matter is still further increased, and for each pound of the compounds used, from 9 to 10 ounces inert salts are produced. These salts accumulate in the bath more and more with every addition of the respective copper salt, and finally yield such a dense solution, which being overloaded with these waste compounds, cannot be worked in a satisfactory manner any longer, the plated articles being blistered and the solutions are of necessity discarded. The reason for this is that a bath of this kind has a relatively low metal concentration and a much higher one of the inert salts. As a rule, the electric current deposits the metal easiest to discharge, which in this case, is the alkali metal. Therefore, as the current density increases, an excess of hydrogen is generated, which causes burning, and the current output drops considerably.

After considering this crude method of forming copper cyanide, one should remember that the copper in a cyanide plating solution is in the cupro stage, while copper carbonate, copper sulphate, copper acetate are cupri salts, and cupri-cupro sulphite is a mixture of both. This means these salts must be first reduced to the cupro state before they are fit for plating. This reduction is executed at the cost of the sodium cyanide, which is actually intended for bringing the copper metal into solution only. Further, neutral copper salts as copper acetate, copper sulphate and cupri sulphite, when brought in contact with cyanide solutions form cupri cyanide first, which, being an unstable compound, decomposes into cupro cyanide and cyanogen, which latter escapes into the air, and on account of its highly poisonous character, is most detrimental to the health of the plater.

Taking into consideration all the disadvantages resulting from the present method for producing a plating solution, every progressive plater should greet with joy the fact that a chemically pure cupro cyanide is now on the market at a price making its use more economical than that of any other copper salt.

Cupro cyanide contains nothing but the ingredients necessary in a plating solution — copper and cyanogen — so that by dissolving it in cyanide solution no inert, unnecessary products are added. This enables the plater to have perfect control of his solutions at all times, as whenever metal is needed, he adds it in the form of copper cyanide, and when cyanide is needed, sodium cyanide. On account of its high percentage of metal—it contains 70 per cent pure copper, the rest being cyanogen—solutions highly concentrated in metal can be worked at a relatively low specific gravity. This is a further advantage, as a bath low in density is much more easily controlled than a very concentrated one.

Economies Effected

Copper cyanide being a cupro salt, does not consume cyanide in order to be transferred to the cupro stage, and because of its being a cyanide itself, it requires less sodium cyanide than any other copper salt to yield the double salt, sodium copper cyanide, the essential constituent of a plating solution. This fact points out a more economical method for producing a plating solution. In other words, it saves money. When one buys a metal salt for plating, one should not forget that it is not the price of the metal in the salt itself which constitutes the economy of the salt, but the price at which the metal is put into solution as a double cyanide. It is this economy of the copper cyanide combined with its high technical qualities, which makes copper cyanide superior to any other plating salt.

The following figures give a comparison of plating solutions produced with different copper salts, and are the results of actual tests. The metal contents of the following solutions are the same:

COPPER CYANIDE—70 PER CENT COPPER.

100 lbs. copper cyanide at 42c per lb.	$42.00
100 lbs. sodium cyanide, 29 per cent, at 22c per lb.	22.00
	$64.00

COPPER CARBONATE—50 PER CENT COPPER.

140 lbs. copper carbonate, at 14c per lb.	$19.60
239 lbs. sodium cyanide, 29 per cent, at 22c per lb.	52.58
	$72.18

CUPRI-CUPRO SULPHITE (TERMED RED COPPER COMPOUND)—40 PER CENT COPPER.

175 lbs. red copper compound at 30c per lb.	$52.50
160 lbs. sodium cyanide, 29 per cent, at 22c per lb.	35.20
	$87.70

COPPER ACETATE—31 PER CENT COPPER.

220 lbs. copper acetate, at 25c per lb.	$44.00
193 lbs. sodium cyanide, 29 per cent, at 22c per lb.	42.46
	$86.46

After continuous operation for two hours, it was found that while the solution made up with copper cyanide remained almost constant, that is, the relative proportions of metal and cyanide were practically the same, the solution made up with the other salts became unbalanced. The anodes coating over required further additions of cyanide, showing once more that solutions made up with chemically pure copper cyanide gave maximum efficiency.

As so-called copper carbonate was the most extensively used, I gave this solution special attention and found, after considerable experimenting, that in order to obtain a solution with sufficient free cyanide to obtain a fairly balanced solution the following proportions were necessary:

140 lbs. copper carbonate, at 14c per lb.	$19.60
280 lbs. sodium cyanide, 29 per cent, at 22c per lb.	$61.60
	$81.20

These comparative figures vindicate once more one of the most important rules in chemistry—that pure materials not only give the greatest efficiency, but are the most economical.

The technical advertising service department, operated by Charles Eckert Young, has been removed from the First National Bank building, Chicago, to suite 1,109 Ellsworth building, 537 South Dearborn street. Mr. Young recently has added to his staff Joseph H. Everston as copy writer. Mr. Everston formerly was sales manager of the Arex Co. Edwin Carroll has been appointed art director.

The Economy and Efficiency of Copper Cyanide

Various Solutions Are Given for Plating Different Classes of Work, With a Few Remarks on Current Density

By Charles H Proctor

THE paper appearing on page 197 is interesting from a technical standpoint, and it is my intention to take up the practical side of electro-plating and give a demonstration by preparing copper and brass solutions. In these solutions I shall plate the various metals such as cast iron, zinc, steel, antimonial lead alloys and die casting metal.

In the past, copper solutions have been prepared with various materials. The majority of platers used so-called copper carbonate, which is in reality a sub-sulphate of copper, the metal contents of which varies from 45 to 52 per cent. Some platers are still preparing solutions with copper acetate, which tests in the neighborhood of 30 per cent copper, and others are using cupri-cupro sulphite of copper, which is known in the market as red copper compound, testing about 40 per cent copper.

Enormous Waste

Although the plater knew that of these materials the metal was the only ingredient of value to him, still he was forced to use such impure salts. He, of necessity, had to add about 50 per cent of inert matter when using the so-called copper carbonate, 60 per cent when using cupri-cupro sulphite of copper, 69 per cent when introducing acetate of copper. You can readily appreciate that after a few additions of metal salts the bath became filled with these inert salts and impurities, increasing the density of the bath to such an alarming proportion as to necessitate the dilution of the solution and finally the discarding of the plating bath. The plater realized that this was a most expensive operation, and has therefore looked for a material free from impurities which would make this waste unnecessary.

The silver plating industry first realized the enormity of this waste and silver cyanide has been used in the large silver plating establishments for the past generation or two, having displaced silver chloride and silver nitrate. The platers of copper, brass and bronze who had to deal with base metals have not given this wasteful practice the consideration it deserved, but as the plating of brass and copper is assuming such large proportions, the plater has been forced to give this matter his attention.

Every plater knows that no matter what copper salt is used in a cyanide solution, it must first be converted into a copper cyanide and then cut down with sodium cyanide to form the double sodium copper cyanide. He has endeavored to secure a chemically pure copper cyanide, as with such a material he would introduce into his bath only the active ingredients necessary for results, that is, metal and cyanide, and at the same time eliminate one operation—the conversion of the carbonates, etc., into copper cyanide.

Copper cyanide is nothing new. It has been available for years, but unfortunately it could only be obtained at a price which made its use prohibitive. The plater has had to continue the use of impure salts. He has had to continue clogging up his solutions with dead salts, which, while they gave results for the time being, forced the plater to discard, or at least partially discard, the baths when they became too dense. Every plater knows that a dense solution is harder to manipulate and control and that it requires more current to get a satisfactory deposit. He has had to contend with an unknown factor, the nature of which he had no way of determining. Recently, however, copper cyanide has been put on the market at a price which not only makes its use possible, but which actually results in a decided saving in chemical costs.

Copper Cyanide Chemically Pure

Chemically pure copper cyanide, testing 70 per cent copper, the balance of 30 per cent being pure cyanogen, is now at the disposal of the plater. He knows that with such a chemically pure salt a solution can be made up which will contain only that which is necessary for results, and knowing this, the solution can be controlled with absolute certainty. As the plater is constantly striving to better his conditions and putting his plating department on a sounder basis, it will only be a matter of a comparatively short time when this high grade metal salt will entirely displace the copper salts heretofore used in cyanide solutions. Why should a plater continue using so-called copper carbonate, which contains about 50 per cent impurities and which must first be converted into a copper cyanide, when he can introduce chemically pure copper cyanide into his bath direct, especially when a solution made up with chemically pure materials can be controlled with absolute certainty? When the bath needs metal, the plater adds it in the form of copper cyanide, and when it requires cyanide, he adds it in the form of sodium cyanide. In other words, he is now able to make up a solution which will give the best possible results in the shortest time and remain constant and well balanced.

Solution

In the solutions which I will prepare, I will confine myself strictly to chemically pure materials. The copper bath will be prepared as follows:

Water	5 gallons
Copper cyanide	15 ounces
Sodium cyanide	15 ounces

I will prepare the brass solution according to the following recipe:

Water	5 gallons
Copper cyanide	15 ounces
Zinc cyanide	5 ounces
Sodium cyanide	20 ounces

Of course, by the elimination of the inert salts, the solution will be less dense. The copper solution will stand about 3½ degrees Baume. In making up a copper bath I have only used 6 ounces of chemicals per gallon, while to make up a solution of the same metal contents with copper carbonate, I would have to use over 12½ ounces of material per gallon, thus increasing the density over 100 per cent. To make up a copper bath of five gallons to contain the same amount of metal as this solution contains, it would be necessary to use 21 ounces of copper carbonate. To put this in solution so as to obtain sufficient free cyanide for results it would require about 42 ounces of sodium cyanide.

It is time that the practical electro-

From the *Bulletin*, published by Lewis Institute, Chicago.

plater discarded the Baume scale as a test for solutions, as any material that is soluble in water adds to the density of the bath and the Baume scale, therefore, does not give the plater any idea of the condition of his solution. With the constant addition of metal salts which contain large proportions of inert matter, the density will rapidly increase, while the solution may be practically void of metal. The plater must use chemically pure materials or else discard the Baume scale as an index to the condition of his bath.

Relative Cost

The cost of the copper solution is 12 cents per gallon, while to make up a solution with the same metal contents, using so-called copper carbonate, would cost the plater about 25 per cent more. When we take into consideration that many plants operate thousands of gallons of solution, this economy is a considerable item. On the face of it the metal cyanides appear more expensive. The market price of copper cyanide is from 42 to 45 cents per pound, while the so-called copper carbonate is quoted at 14 cents per pound. The plater must not lose track of the fact that copper carbonate or copper cyanide either, for that matter, has absolutely no value as such. It only becomes of value to the plater when put in solution with cyanide. It is here where the plater saves. He requires only about one-third the quantity of cyanide to put in solution a given amount of copper in the form of copper cyanide as compared with copper carbonate. For instance, the cost of one pound of copper cyanide (70 per cent metallic copper) put in solution with sufficient free cyanide to obtain an immediate deposit is—

1 lb. copper cyanide, at 42c per lb.	42c
1 lb. sodium cyanide, 29 per cent, at 22c per lb.	22c
	64c

To put in solution the equivalent amount of metal in the form of so-called carbonate of copper, 50 per cent, you require—

1 lb. 6 ozs. copper carbonate at 14c per lb.	19¼c
2 lb. 13 ozs. sodium cyanide, 29 per cent, at 22c per lb.	60½c
	79¾c

Another factor which must be considered is the current density. It is a well known fact that a dense solution requires a higher electrical pressure, as the inert matter from the metal salts acts as a retarding agent. Of course, the rapidity of the deposit is governed by the ampere law, which teaches us that the more amperes which can be carried upon a given surface the more rapid will be the deposit. The inert matter being eliminated by the use of the metal cyanides, the plater is able to increase the amperage about 25 per cent, and this enables him to reduce the time necessary for results, increasing the output accordingly. The plater, therefore, is able to turn out more work in a given time without increasing his tank area, which is another decided economy.

Thus neither copper carbonate nor copper cyanide as a single factor must be taken as a basis of calculating their relative costs in the plating solution, but when we take the solution complete, ready for operation, as a basis, there can be no doubt that with chemically pure materials the plater not only obtains a solution of maximum efficiency, but is able to materially reduce the plating costs. Once this fact is brought home to the plater, it will be a comparatively short time when chemically pure metal cyanides will entirely displace the materials of doubtful purity formerly used.

Standard Solution

The fact that all copper salts in a cyanide solution must first be changed to a copper cyanide simplifies matters greatly, as copper cyanide can be added to any copper cyanide solution, no matter what salt was originally used to install the bath in question. The plater has obtained results with materials which were at his disposal, but it was always with a degree of uncertainty as to how the bath would behave. This uncertainty is entirely removed once a plating solution is standardized, and this ideal condition can only be reached with the use of metal salts which are correct from a theoretical and practical standpoint, and it cannot be disputed that the only metal salts which answer these purposes are the metal cyanides.

Central Foundry Supply's New Line

The rights to manufacture the complete line of foundry equipment formerly built by Byram & Co., Detroit, have been acquired by the Central Foundry Supply Co., Columbus, O. This line includes the Colliau cupola, Byram ladles, tumbling mills, turntables, foundry cars, hand-power jib and traveling cranes, core ovens, core oven cars, crucible shanks and tongs, brass melting furnaces, elevators, etc. The Central Foundry Supply Co. can furnish promptly all repair parts for the entire line of equipment formerly manufactured by Byram & Co.

Personal

Leo G. Smith has resigned as works manager of the open hearth and crucible foundries of the Prime Steel Co., Milwaukee, effective May 15.

W. R. Mample, superintendent of the foundries of the Aluminum Casting Co., Fairfield, Conn., has been transferred to the Detroit plant.

George B. Thomas, resident manager of the Cleveland plant of the United States Cast Iron Pipe & Foundry Co. for a number of years, has resigned.

George T. Merwin, formerly connected with the W. W. Butler Co., Montreal, has been appointed general sales manager of the Canadian Car & Foundry Co., Montreal.

Herbert Mathews has resigned his position with the A. B. Enameling & Foundry Co., Battle Creek, Mich., and has been appointed superintendent of the plant of the Rudy Furnace & Stove Co., Dowagiac, Mich.

G. W. Mead resigned his position as foundry foreman of the stove plant operated by the estate of P. D. Beckwith, Inc., Dowagiac, Mich., to accept a similar position with the Rudy Furnace & Stove Co., of the same place.

Daniel Runkle, formerly affiliated with the Warren Foundry & Machine Co., has been appointed New York representative of the Standard Cast Iron Pipe & Foundry Co., whose offices are located at 61 Broadway, New York City.

Charles E. Mack has been appointed general manager of the John Wood Iron Works, Portland Ore., engineers, founders and machinists. Mr. Mack succeeds to the vacancy caused by the death of John Wood, president of the company.

J. B. Wilson, of the Davis-Bournonville Co., New York, read a paper on oxy-acetylene welding and cutting recently before the Detroit Foundrymen's Association. The paper included a description of the apparatus used for this work, together with data regarding methods employed in welding various metals and cutting steel.

Death of Peter Marschall

Peter Marschall, vice president of the Hansell-Elcock Co., Chicago, died Tuesday, April 20, aged 72 years. He was a native of Germany and came to this country in 1866 and followed his trade as iron molder. When the Hansell-Elcock company was organized, a little over 25 years ago, he entered its employ, and became superintendent and later vice president. His wife died several years ago and he has surviving three daughters and three sons.

How Foundry Equipment is Properly Controlled

The Growing Use of Electrically-Driven Machinery in Casting Plants is Discussed, With Suggestions for Its Regulation

By R H McLain

COST of the controllers for electrical apparatus in foundries present problems which are no different from those in other industries, except possibly that there is more dirt in a foundry than elsewhere. Grinders, mixers, blowers, lifting magnets, etc., are the same in the foundry as in other shops and really require no separate treatment. A foundry crane, however, is different from other cranes, due to the necessity of handling flasks at a very low speed when drawing patterns. Some new devices have been recently developed which have a peculiar relation to the foundry, such as electric welding machines, electric furnaces, etc. It is the object of this paper to deal briefly with those types of motor control which resemble closely the controls used in other industries and to deal more fully with the theoretical side of crane control.

Miscellaneous machines, such as blowers, grinders, mixers, dryers, conveyers, etc., require good substantial hand or automatic starters, capable of starting the apparatus a few times a day. The reliability of these controllers and their safety are greatly enhanced by enclosing them and thus protecting workmen from electrically charged parts; this also protects the controller from dirt.

Lifting magnets are used extensively in many of the larger foundries where large quantities of scrap or pig iron have to be handled. As is the case with so many other devices, it seems that the control is the key to the situation here. In large magnets it is difficult and dangerous to disrupt the exciting current suddenly because the long induced arc burns up the controller parts, and the high induced voltage will ultimately destroy the insulation of the magnet winding. To overcome these objections, a discharge rheostat is connected to the solenoids before the exciting circuit is interrupted. Of course, the discharge rheostat causes the magnet to be very slow about losing its magnetism, and consequently in releasing its load. Controllers are provided with a spring-return reverse point which gives, through preventive resistance, a partial reverse exciting current, so as to hasten the release of the load. Reverse excitation need not be used except where it is advantageous to gain time.

The controlling devices used on arc welding equipment and electric furnaces are usually combinations of hand and automatic units and are comparatively simple.

Arc Welding

The standard arc-welding generator delivers power at from 60 to 75 volts, and the amount of current used is varied by a rheostat in series with the arc. On small machines a dial switch is used and in large capacities knife blade switches give better results.

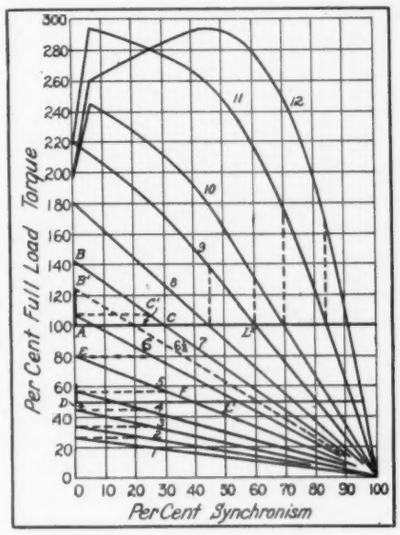

FIG. 1—SPEED-TORQUE CURVES OF WOUND-ROTOR INDUCTION MOTOR WHEN CONTROLLED BY A 12-POINT RHEOSTATIC CONTROLLER

In order to protect the generator against overloads and make it unnecessary for the operator to leave his work to close circuit breakers, an automatic protection is given by a series relay controlling a shunt contactor that normally short circuits a preventive resistance. When too much current is taken, the preventive resistance is connected in series with the arc and the operator is prevented from injuring the generator and disturbing other operators.

The use of arc furnaces in refining steel requires a constant power control which is obtained by a balanced current relay controlling contactors for starting, stopping and reversing the electrode motors. This control has advantages over devices formerly used, especially in comparative freedom from opening the main oil switch. A double-throw switch is connected in the control circuit which can be operated by hand on starting the furnace, and thrown over to automatic position as soon as the furnace reaches normal operating conditions.

In electric resistance furnaces, operating at a lower temperature than arc furnaces a constant temperature control is used. This is accomplished by varying the voltage impressed on the furnace by taking advantage of the characteristics of the resistor which, in this type of furnace, decreases in resistance as the temperature increases, and vice versa.

By manipulating a simple relay, the contactors are arranged to connect the resistor to a low voltage when the current has increased to a certain point, and to a high voltage when the current has decreased in a similar way. The operation of this control equipment has been very successful, the chart obtained from a recording pyrometer giving practically a straight line.

The crane is the most important, as well as the most expensive, electrically-operated machine in a foundry, and consequently, a very careful study should be made before selecting cranes. The distribution of heavy and light cranes over the floor should suit the work to be done. A very good solution of this problem in a large foundry is to have large overhead cranes and small wall cranes, which serve as feeders to the large ones.

The maximum full-load hook speed for which the motor is geared is of vital importance. A careful analysis of the amount of work to be done and the delicacy of the operations should be made, and the proper speed determined from these data. The temptation is always to make the speed as great as possible, but there are certain definite limits beyond which it is not advisable to go. Forty feet per minute is a speed which has met with very general favor on 5-ton cranes, and even 60 feet per minute is in use in at least one foundry where every conceivable kind of work is done. Fifteen feet per minute is quite common on larger cranes. The only trouble on cranes geared for the

A paper read at the Pittsburgh meeting of the American Institute of Electrical Engineers, April 15, 1915. The author, R. H. McLain, is associated with the General Electric Co., Schenectady, N. Y.

higher speeds, is that at times a uniform creeping speed of around 1 to 5 feet per minute, must be obtained from drawing patterns, etc. With direct current it is not so hard to obtain this creeping speed, whereas with alternating current it is very hard unless the crane is geared for a slower speed than the direct-current crane. In either case, a well built crane, and a good system of mechanical brakes, make a decided difference in the accuracy of control.

I know of a case where a crane is designed to take care of only one kind of work, and when this crane was first proposed, 40 feet per minute was, as a matter of course, chosen for the proper maximum hook speed. The crane was to be used for drawing very thin patterns and was to be driven by alternating-current motors. An investigation of the exact cycle of operations showed that a hook speed of 12 feet per minute would do just as much work in a day as would 40 feet per minute. With this lower hook speed, alternating current was ideal in operation. Indeed, there are few cases where it is necessary to change the form of power from alternating current to direct current merely to accommodate foundry cranes, provided the crane itself is built properly, fitted with the proper mechanical load brakes and the maximum full-load hook speed is of the correct value.

Controller Requirements

On a crane running at 60 feet per minute, or less, a controller viewed from the standpoint of the operator, really needs only two points for hoisting and two points for lowering. The first point should give a uniform creeping speed regardless of the load, and would be used for performing delicate operations. The second point on the controller should give maximum speed, and would be used for making quick trips in transferring the material. Of course in ordinary commercial controllers more than two points of control are necessary in order to transfer the motor speed, without undue shock, from the creeping speed to the maximum speed and vice versa; and there is no objection, from an operating standpoint to having several such points of control.

To obtain this desired form of control a simple rheostatic controller can be used, because the torque on the motor depends directly on the amount of hook load, and the speed can be controlled simply by inserting resistance in series with the armature, or into the secondary circuits of a wound-rotor induction motor, thereby cutting down the speed to the desired point. However, when lowering, the tendency is for the load to make the motor run away, and it is necessary either to use dynamic braking control or to equip the crane with some form of a mechanical load brake. This mechanical load brake is an automatic friction braking device which not only holds back against the falling hook load, but also requires power from the motor to drive it in a downward direction; consequently, in so far as the motor is concerned, the work and method of control for lowering is very much like the conditions when the hook is being hoisted, except that the torque required from the motor is practically constant regardless of the amount of load on the hook, whereas in hoisting, the torque depends directly upon the hook load.

Fig. 1 shows the speed-torque curves of a wound-rotor induction motor on the various points of a 12-point rheostatic controller, arranged for foundry service. The object to be attained in laying out such a controller is to provide rheostats

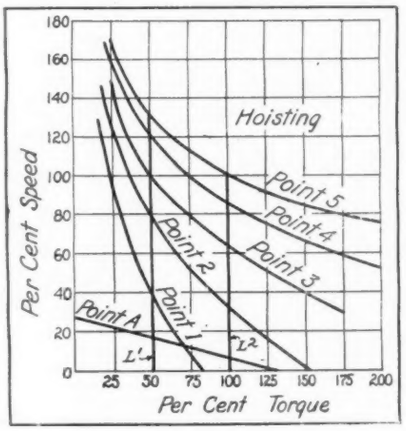

FIG. 2 — SPEED-TORQUE CURVES OF DIRECT CURRENT, SERIES WOUND MOTOR WHEN CONTROLLED BY FOUNDRY TYPE CONTROLLER —HOISTING SIDE

of sufficient value and also a sufficient number of controller points, so that as low a value of creeping speed can be obtained as is desirable or necessary for whatever range of torque values the motor will encounter.

Varying the Speed

With a controller arranged as is shown in Fig. 1, and provided with large travel of handle and substantial type of resistance, it is easily possible to handle, on a well designed crane, any kind of foundry work for maximum hook speeds up to something like 40 to 60 feet per minute. However, a great deal of care would be required from an operator to obtain the desired uniformity of speed control when trying to maintain a speed of around 10 per cent of the maximum. On account of this, it is not advisable to use such a high maximum hook speed where a large percentage of the time is spent in maintaining a creeping speed. In a large number of foundries there is, of course, little occasion for extreme low speeds and at all other times the high maximum speed is of great advantage in foundry operations.

I have made a few calculations which show, in definite figures, how quickly an operator is required to turn his controller from one point to another in order to keep the speed down to a low value.

Operator Must be Alert

Assume a load requiring 100 per cent torque from the motor for hoisting, and, as is usually the case, assume that 25 per cent extra torque is required to break static friction. It will, therefore, be necessary to turn the controller to point seven, Fig. 1, before the motor will start. The motor will accelerate to 30 per cent of normal speed if the controller is left on this point. The area *A B C* represents the value of torque available for accelerating. If we assume that 100 per cent of the motor torque would be required to accelerate the load, crane and motor parts to full speed in one second, we have the following speed-time curve:

5 per cent speed in 0.128 second
10 per cent speed in 0.284 second
15 per cent speed in 0.484 second
20 per cent speed in 0.774 second
25 per cent speed in 1.224 seconds

Since it is an easy matter for a trained operator to act in less than 0.2 second, the operator will have ample time to turn back to point six before the speed reaches more than 7½ per cent. The hook would then proceed at a uniform speed of 5 per cent on point six. These statements, of course, presuppose absolute uniformity of supply voltage and frequency, also uniform torque requirements from the motor.

In order to compare operation with an infinite number of points as against a definite number of points, I have drawn in the dotted line between point six and point seven in Fig. 1 and labeled it point 6½. This represents the speed-torque curve which gives exactly the correct value of torque to start the load, namely, 125 per cent. On such a point, we would have the following speed-time curve:

5 per cent speed in 0.218 second
10 per cent speed in 0.514 second
15 per cent speed in 1.014 seconds

It will be seen that on this point, the motor would attain a uniform speed of 20 per cent unless the controller was turned back to a position corresponding to point six, and it is, therefore, evident that there is no particular advantage in having an infinite number of points unless perhaps it gives the operator a little more time in which to act. However, unless such a controller is so constructed

that the travel of the handle, corresponding to a change from one torque curve to the other, is large, such an advantage immediately disappears. Since the total travel of the controller handle is necessarily limited to that which is convenient for an operator's hand, the limit to the advantage of adding to the number of controller points is quickly reached.

When a direct-current, series-wound motor is used, speed-torque curves as shown in Fig. 2 can be obtained by rheostatic control in exactly the same manner as shown for alternating current in Fig. 1. A typical case would be represented by a controller which would be provided with five points. With such a controller the same difficulty in maintaining a creeping speed would be encountered as with alternating current, —that is to say, such a controller would begin to introduce some difficulties in operation when used for a maximum hook speed of greater than about 15 feet per minute. However, if instead of point one we arrange for point *A* by connecting some resistance in parallel with the armature and some resistance in series with the armature and field, then it is a very simple and easy matter to obtain the desired creeping speed.

Arrangement of Resistance

In Fig. 2, point *A* is obtained by arranging the resistance so that at standstill 170 per cent of normal current flows from the line through the series field, and of this current, 136 per cent of normal flows through the armature; whereas, when the motor is running with no torque at all, the voltage across its armature will be held down to 27 per cent of normal voltage by means of the shunted resistance across the armature. Curve *A* shows that with a load requiring 100 per cent torque from the motor for hoisting and not over 137½ per cent torque to break static friction, a creeping speed of 7 per cent of normal speed can be obtained. On 50 per cent load, a creeping speed of 16 per cent can be obtained. If necessary, another curve lower in value than point *A* can be provided. This curve shows clearly two marked advantages for the direct current over the alternating current. First, a lower value of creeping speed can be obtained, and second, no especial skill or attention is required of the operator in order to obtain it. The controller is simply turned to the first point and left there without further attention.

For lowering, either a mechanical load brake or dynamic braking should be used. Of course on an alternating-current motor it is possible to obtain regenerative braking—that is, when the motor is driven above synchronous speed it acts as a generator

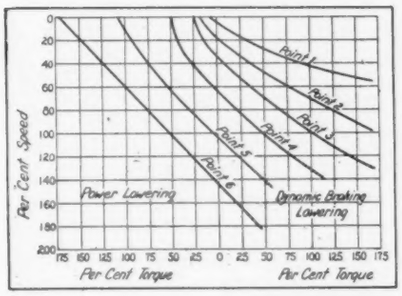

FIG. 3 — SPEED-TORQUE CURVES OF DIRECT-CURRENT SERIES WOUND MOTOR WHEN CONTROLLED BY FOUNDRY TYPE CONTROLLER —LOWERING SIDE

and retards the driving load. Such a motor, equipped with a substantial solenoid brake, would give the desired maximum speed control of the crane, but would not give the desired creeping speed control. With direct current it is possible to connect the motor for lowering so that any desired speed can be obtained uniformly. Fig. 4 shows the connections of a controller arranged to give dynamic braking for lowering. Points one, two, three, four and five in Fig. 2 shows the speed-torque curves on similar points of the hoisting side of this controller. Points one, two, three, four, five and six in Fig. 3 represent the speed-torque curves on points one to six respectively on the lowering side of this controller. These latter curves show that when torque is required of the motor to drive the load downward each point of the controller will give a certain amount of torque; whereas should torque be required to hold back a falling load, this same point on the controller will give this required torque at a slightly higher speed. Consequently there is no danger of the load running away on any point.

For maximum hook speeds of 15 feet per minute and less, ordinary rheostatic controllers are practically always suitable without special precautions being taken to adapt them for foundry service. For maximum hook speeds above 15 feet per minute it is sometimes necessary to adopt special arrangements. On direct current, a convenient method is to use a shunting resistance across the armature for obtaining creeping speed. For alternating current, it is necessary to provide a larger number of controller points and sufficient resistance to reduce the torque at starting to about 25 per cent of normal. While it is true that direct current gives a nicer and more convenient control for creeping speeds, yet alternating current provides good enough control for practically all cases. Where a foundry is large enough to admit the use of several different cranes, each having a different value of maximum hook speed, the shortcomings of alternating current disappear almost altogether. Even where only one or two varieties of cranes are used, alternating current may give entire success, provided most of the creeping speed work requires not less than 25 per cent of normal speed, and only a small portion of the creeping speed work requires as low as 10 per cent of normal speed. The success of this latter arrangement depends largely on the efficiency of the mechanical load brake, solenoid brakes and gearing which are furnished with the crane. Where alternating-current power is supplied by a power company, it is, therefore, rarely necessary to go to the extra expense of converting this power into direct current so as to accommodate foundry cranes.

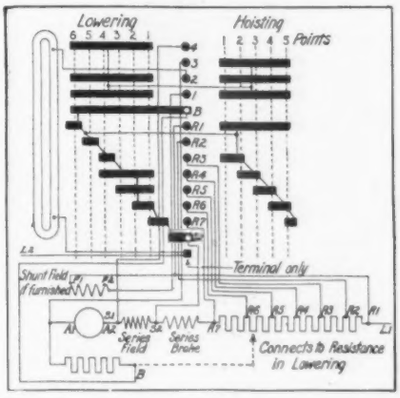

FIG. 4—CONNECTIONS OF CRANE HOIST CONTROLLER WITH DYNAMIC BRAKING ON LOWERING SIDE

Snyder Furnace Installation

The Snyder Electric Furnace Co., 53 West Jackson boulevard, Chicago, is completing the installation of a second three-ton electric furnace for the Otis Elevator Co., Buffalo. This furnace will be provided with a basic lining and will be employed for refining steel for casting purposes. The contract for the second furnace was closed nine months after the first electric furnace was placed in operation in this plant.

A small electric furnace also is being installed in the plant of the Niagara Electric Steel Corporation, North Tonawanda, N. Y. This furnace will be lined basic and will have a daily output of six tons of steel. In addition to these furnaces, the Snyder company is completing the installation of three electric furnaces to be used in special chemical work. Another furnace of an entirely different type is now under construction.

The Layout of a Model Malleable Iron Plant

New Foundry of the Hammond Malleable Iron Co., Hammond, Ind., Which Has Many Novel Features

THE Hammond Malleable Iron Co., Hammond, Ind., has recently placed in operation a plant designed for economically handling raw materials and finished products, with ample provision for future extensions as conditions may demand. Special care has been exercised to render the plant fireproof and the buildings are constructed entirely of concrete and steel, except the sidewalls which are brick. The steel columns which are embedded three feet in the concrete foundation, support the steel roof trusses, the roof itself being sheathed with copper-bearing rust-resisting corrugated steel sheets. The brick walls fill the space from the foundation to the bottom of the sash, the lower course of glass being ribbed to diffuse the illumination and to promote privacy. Steel sash are used, furnished by the Detroit Steel Products Co., Detroit, Mich. Automatic window openers control the sash in the walls and in the monitors from the floor.

A general plan of the plant is shown in Fig. 5. The works occupies 3½ acres, with a tract of similar area alongside reserved for future growth. The Indiana Harbor Belt Railway borders the plant on the rear with a switch extending into the storage yard and shipping room. This road has a connection with every railroad entering Chicago and raw materials and finished castings can be handled direct without

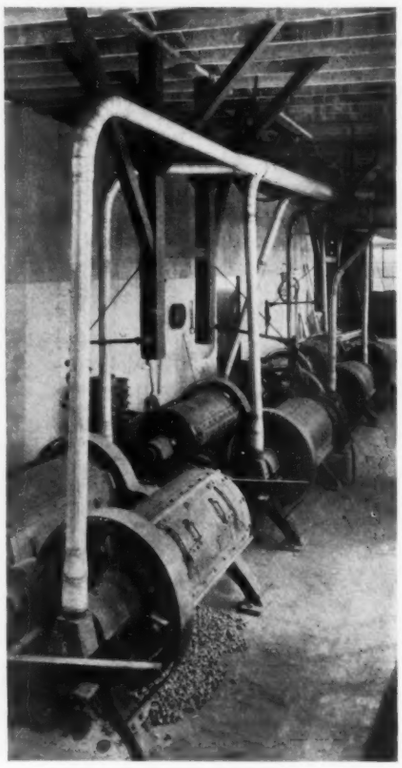

FIG. 1—GROUP OF HARD IRON MILLS

entering the congested railroad yards of Chicago. The Gary & Interurban Railway Co.'s tracks pass the door, affording convenient communication with Hammond, Gary and other towns in the South Chicago industrial section. Hammond is 19 miles from Chicago and is part of the manufacturing district comprised in East Chicago, Whiting, Indiana Harbor, Hegewisch and Gary.

The main building, which is 70 x 340 feet, lies with its long axis extending from north to south. The annealing and shipping departments are in a building 80 x 160 feet, leaving a storage yard between 35 feet wide, where pig iron and furnace coal are unloaded.

These buildings are connected along the front by a structure 20 x 185 feet in which are housed the carpenter shop, hard iron mills, pattern shop and superintendent's office. The main office and fireproof pattern storage are in small buildings west of the plant.

This arrangement has in view compactness and at the same time a regular sequence in manufacturing operations from raw to finished products. The result is a horseshoe-shaped plant in which the materials start at one end and are delivered at the other; at the same time this layout makes it possible to receive and dispatch freight over a single railway track.

The plant is unusual in that the stack leading from the air furnace is in the middle of the molding room. The firing doors are situated in a bay at one side and the smoke emitted when the doors are opened with the blast on is conveyed out at once through special ventilators in the side walls. The molding floors

FIG. 2—THE MOLDING ROOM IS CLEAN AND SPACIOUS, SPECIAL VENTILATORS BEING EMPLOYED TO CARRY AWAY SMOKE FROM THE AIR FURNACE

are thus kept clear of fumes and smoke. The coal bunkers are but a few feet from the firing door, and the blower is close to the fire box.

The furnace is of 20 tons' capacity with a possibility of 24 tons being melted. The bung frames are of special type with hinged ends, making them easy to fill and empty, the end casting being simply raised to release the brick. A hoist and monorail is installed over the furnace. The steel stack is self-supporting; it is tied to anchor bolts set in 6 feet of concrete.

Provision is made for 68 molding floors, 10 x 32 feet each, with a central concrete gangway 6 feet wide. Molding machines specially designed by L. E. Keen, superintendent of the plant, are provided on every floor. They are of the swing head type with air squeeze. They will take flasks up to 36 inches square. The machine probably will be put on the market.

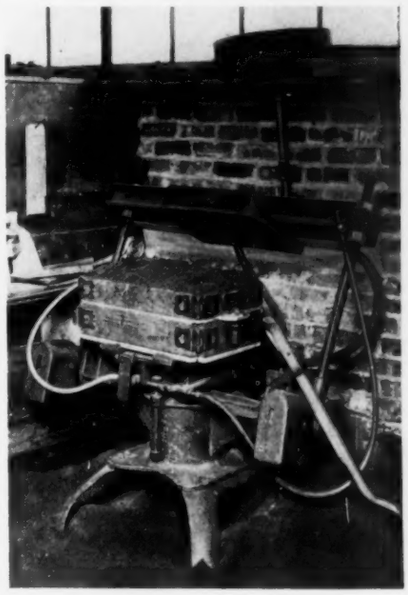

FIG. 3—SWING HEAD SQUEEZE MACHINE

The core room which is situated at the north end of the foundry, is equipped with core ovens and a 9-foot Blystone sand mixer.

The hard castings are taken from the foundry to the mill room, Fig. 1, where 10 exhaust tumbling barrels clean them before packing in the annealing saggers.

Three annealing ovens, each of 20 tons capacity are provided, with space for three others. The flue is carried underground to the stack and an opening is provided on the opposite side of the stack base for a flue from the proposed set of three ovens. The floors of the ovens are built up with 4½ inches of ganister over clay tile followed by a course of paving brick. The approach is across a wide trench in front of the doors, which gives access to the ends of the flues; the latter can be cleaned readily by removing the light plugs of fire clay and brick which close the arches leading through the front walls below the sills. An interesting feature is that a concrete floor is laid in the annealing room and as soon as this has settled and gained its final grade a creo-

(*Continued on page* 208.)

FIG. 4—AIR FURNACE WITH STACK IN CENTER OF MOLDING ROOM

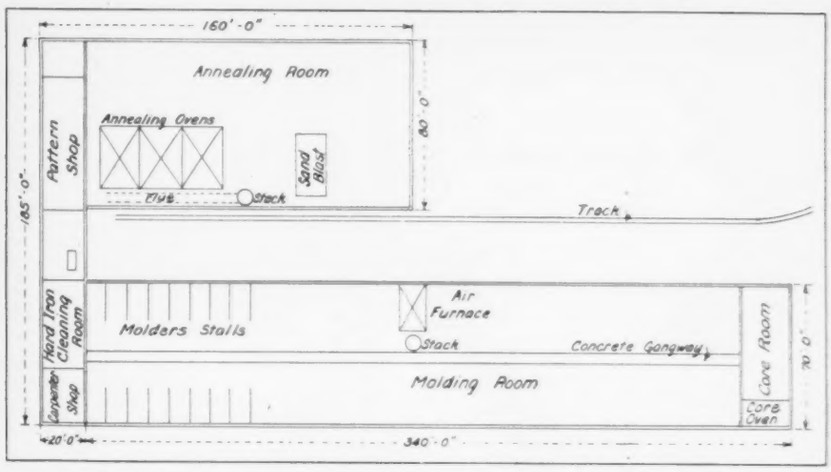

FIG. 5—PLAN OF FOUNDRY OF HAMMOND MALLEABLE IRON CO.

FIG. 6—A CORNER IN THE ANNEALING ROOM

THE FOUNDRY

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Trade Outlook

FOUNDRY trade conditions display a distinct upward tendency and the heavy shipments of pig iron to casting plants generally reflects a greatly increased melt. The improvement parallels that noted in other lines of business and foreshadows the gradual resumption at capacity of many plants that have operated with reduced forces for more than a year. While pig iron prices display no advancing tendency, nevertheless the market is stronger than it has been since the beginning of hostilities last summer. The increased production of March is going to be eclipsed by the total of April, and with idle stacks blowing-in, not many months will elapse until the output is again on a normal basis. The establishment of the season's ore prices on last year's basis removes another obstacle that had a tendency to unsettle the iron market. Lake ore shipments, according to early predictions, will exceed last season's total by approximately 10,000,000 tons, this prediction now being made, although 60 days ago conditions did not favor a ton's increase in shipments. The pendulum of public opinion is swinging gradually from the extreme of pessimism to a feeling of optimism and conditions underlying the entire business fabric justify the more hopeful spirit. While the aggregate of the so-called war orders may be discounted considerably, nevertheless the total still reaches stupendous figures. Machine tool builders are crowding their plants to the limit to meet the demand for equipment for the manufacture of shrapnel and foundries in the Cincinnati and New England districts are operating at capacity to supply the casting needs. The automobile trade fails to reflect the effects of the depression and car builders are establishing new output records in their endeavor to fill orders. More activity also is being displayed by the railroads and several equipment orders have been awarded during the past 30 days. It is doubtful, however, that the railroad buying will become considerable of a factor for several months, as large financing will have to be done by many of the roads before they can map out extensive equipment buying programs. Steel foundries specializing in railroad work are operating at considerably below normal capacity and not until car buying increases will their tonnage be increased materially. The non-ferrous metal market seems intent upon establishing new high levels. Tin is selling at 43 cents, New York, and prime western spelter is quoted at a range of 12 to 12.5 cents, St. Louis. The copper market, which is on the basis of 17.75 to 18 cents for electrolytic and 21 cents for best lake grades reflects a limited production rather than a greatly increased domestic demand. While shipments abroad have been heavy, they are not in sufficient volume to advance prices to their present levels. In the leading producing centers, foundry grades of pig iron are quoted as follows: No. 2, Pittsburgh, $13.45; Cleveland, $13.25; Chicago, $13; Philadelphia, $14; Buffalo, $12.25, and Birmingham, $9.50; malleable is held at $13, Chicago, and $12.50, Buffalo, while Lake Superior charcoal is quoted at $15.75, Chicago and Buffalo.

Death of Edgar H. Mumford

Edgar H. Mumford, president of the recently organized E. H. Mumford Co., and who for many years was prominently identified with the molding machine manufacturing industry, died at his home in Plainfield, N. J., on April 18, following a short illness. From the time of his affiliation with the Russel Wheel & Foundry Co., Detroit, in 1889, Mr. Mumford played a prominent part in the development of mechanical devices for the production of molds and cores and to him must be attributed a large part of the advance that has been recorded in molding practice in the last 25 years. Mr. Mumford entered the foundry industry well - equipped with a technical education and he centered his attention on the elimination of hand labor in molding practice. His inventions followed in rapid succession and many of the existing types of molding machines are built according to his designs. Mr. Mumford was born at Groton, Mass., in 1861, the son of Rev. Thos. J. Mumford, a Unitarian clergyman. He was fitted for Harvard university at the Roxbury Latin school, but instead of entering Harvard he matriculated at the Massachusetts Institute of Technology, where he graduated in 1886 with the degree of mechanical engineer. He was one of the six members of his graduating class who were selected by Chas. Francis Adams to take a course of training in the shops of the Union Pacific railroad and within a comparatively short time he was promoted to the position of master mechanic of the Leavenworth division of this railroad. In the fall of 1889 he was appointed superintendent of the Russel Wheel & Foundry Co., Detroit, but in 1892 he left this position to become associated with Henry R. Worthington, Inc., Brooklyn, N. Y. When this company built its plant at Elizabethport, N. J., he was placed in charge of its new foundry, but subsequently he left this position to become manager of the New York office of Bement, Miles & Co., Philadelphia, where he remained until the summer of 1895, when he decided to go in business for himself. In company with Harris Tabor and Angus Sinclair, Mr. Mumford purchased the business of the Tabor Mfg. Co. from Manning, Maxwell & Moore and remained with it in the capacity of secretary for a period of 10 years. For several years the machines designed by the Tabor Mfg. Co. were built at the plant of Samuel L. Moore & Sons Corp., Elizabethport, but in 1900 the business was removed to Philadelphia.

EDGAR H. MUMFORD

In 1905 Mr. Mumford organized the E. H. Mumford Co. and in addition to exploiting its own line of machines, the American rights to the line of molding equipment built by Ph. Bonvillain and E. Ronceray, Paris, France, were secured. In 1909 the E. H. Mumford Co. was sold to the Mumford Molding Machine Co. and the American rights to the French machines again reverted to Ph. Bonvillain and E. Ronceray. Mr. Mumford was elected vice president and general manager of the Mumford Molding Machine Co. and retained his interest in this company until last November. As announced in the April issue of *The Foundry*, Mr. Mumford recently revived the E. H. Mumford Co. and again made arrangements to engage in the manufacture of molding machines at the plant of Samuel L. Moore & Sons Corp., Elizabethport, N. J. The business will be conducted by E. W. Mumford and T. J. Mumford, who are, respectively, vice president and secretary of the E. H. Mumford Co. In 1907 Mr. Mumford was elected president of the Foundry Supply Association, in whose affairs he took an active interest until the organization of the Foundry & Machine Exhibition Co. He also took a prominent part in the work of the American Society of Mechanical Engineers and was a member of the Engineers' Club of New York City, the Art Club of Philadelphia and the American Foundrymen's Association.

M. W. Allen

M. W. Allen, assistant master molder of the United States navy yard, Norfolk, Va., died March 29. Mr. Allen commenced work in 1858 at the age of 16 as an apprentice at the Gosport Iron Works, Portsmouth, Va., and remained there until the beginning of the civil war, when he entered the army as a private in Grimes battery, organized at Portsmouth, Va. At the close of the war he entered the employ of the Atlantic Iron Works, Norfolk, Va., and remained with this concern until 1884, when he was appointed quarterman in charge of the foundry at the Norfolk navy yard. He held this position until 1908, when he was appointed assistant master molder. As a result of the passing of Mr. Allen, the navy is deprived of a highly valued craftsman and the foundry industry at large is poorer through the loss.

Steel Core Trays and Base Plates

The Wadsworth Core Machine & Equipment Co., Akron, O., has again extended its extensive line of core room equipment and is introducing to the foundry trade reinforced steel core-drying trays and snap flask mold base plates. An assortment of reinforced steel core-drying trays is illustrated in Fig. 1 and the utility of this equipment is apparent to every foundryman. These trays are unbreakable, absolutely straight, are cheaper than cast iron and only one-third the weight of cast trays. The use of these trays will prevent crooked cores. Sizes from 9 x 12 inches to 24 inches square are carried in stock, although larger and special sizes also will be made. Round core-drying plates also are manufactured, which are intended for receiving cores after they are turned out by the machines. All of these trays are 26 inches long, one style having six corrugations for cores from ⅜ to 1⅛-inch, and another style has three corrugations for cores from 1¼ to 2¼ inches. Trays for square, hexagon and half-round cores also are made.

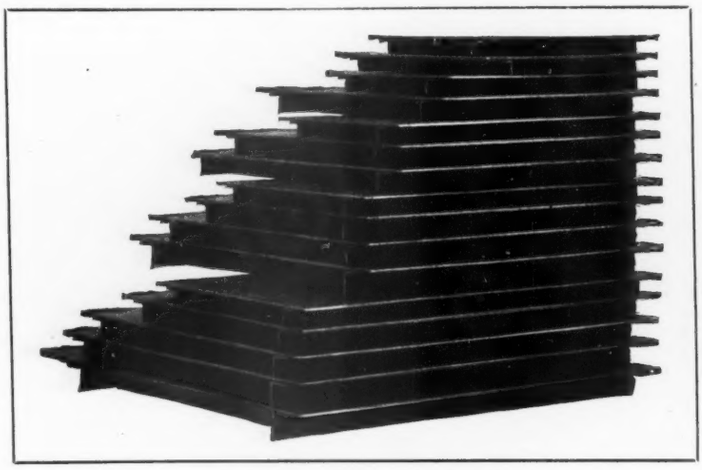

FIG. 1—REINFORCED STEEL CORE-DRYING TRAYS

In Fig. 2 are shown front and reverse sides of the reinforced steel snap flask mold base plates manufactured by the Wadsworth company. These plates are far more satisfactory than wood, owing to the fact that they cannot be burnt and they can be furnished at a cost much less than that involved in making a pattern. Furthermore, they are absolutely straight, are cheaper than cast iron and only one-third the weight. These steel plates are an absolute prevention against burnt bottom boards. They are made in sizes from 9 x 12 inches to 24 inches square, although larger and special sizes will be made.

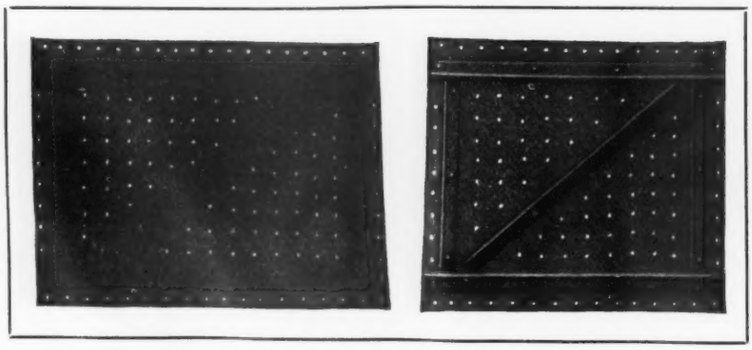

FIG. 2—REINFORCED STEEL BASE PLATES

Improved Sand Shaker

In the accompanying illustration is shown the improved type of sand shaker built by the Hanna Engineering Works, Chicago. The original machine was illustrated and described in *The Foundry*, February, 1901. It consisted of a riddle holder, which was a circular band, and it was arranged with cross bars upon which the riddle was placed. The riddle holder was supported by spring steel uprights and was connected directly to the cylinder, which was of the valveless type and consumed a large amount of air. Improvements of this machine have been numerous and these include a powerful double-acting valve cylinder; a special screen clamp, making possible the instantaneous release and replacement of the riddle, and the most recent addition is a suction lubricator and an ejecting throttle valve. This valve automatically ejects during the period of moving from closed to open positions, any sand that is picked up by the hose while it is disconnected. It is apparent, of course, that this sand, if forced into the working parts, rapidly wears them out, in addition to causing the annoyance of clogging the valve ports.

Layout of a Model Malleable Iron Plant

(*Continued from page* 205)

soted block floor will be laid on it. The annealing ovens are equipped with recording pyrometers furnished by the Brown Instrument Co., Philadelphia, provision being made for six instruments. The coal bunkers are located behind the ovens in the annealing room,

IMPROVED TYPE OF HANNA PNEUMATIC SHAKER

where they are properly insulated from heat and so arranged that coal may be unloaded directly from the cars.

After annealing, the castings are cleaned in two sand blast machines furnished by the W. W. Sly Mfg. Co., Cleveland; they have a capacity of two tons per hour. The same company supplied the tumbling mills for the hard iron castings. An Ingersoll-Rand compressor, furnishing 300 cubic feet per minute, supplies air for the molding machines, sand blasts, forge, whistle, and various other purposes, and a Sturtevant blower provides the blast for the air furnace.

The plant is equipped with General Electric motors, seven being used for various purposes. The compressor is driven by a 50-horsepower motor and

the blower by a 10-horsepower motor. The tumbling mills are direct driven by a 20-horsepower motor provided with a special outboard bearing. In addition to these, the core room has a 10-horsepower motor, the pattern shop one of 7½ horsepower and the carpenter shop is fitted with one of five horsepower.

During the present summer, equipment will be installed to make use of the waste heat from the annealing ovens and air furnace to provide heat during the winter for the work rooms and office.

The officers of the Hammond Malleable Iron Co. are as follows: President, H. J. Wanner; vice president, B. H. Steelman; secretary-treasurer, H. C. Wanner. A specialty is made of automobile and agricultural implement castings and it is said the company began operations with sufficient orders and contracts to run for some time.

First Use of Eye Protectors

So far as can be ascertained, the earliest record of systematic eye protection credits the Crane Co., Chicago, with this safety-first movement. In 1897, this company began to provide eye protectors for its men and in 1898 this work was placed on a systematic basis by furnishing the men with glasses free of charge and the operators, as far as possible, were required to wear glasses constantly when they were exposed to flying bits of metal, emery dust and hot metal. Dr. A. M. Harvey, who was chief surgeon of the Crane Co. at that time and who still serves in that capacity, was the originator of this plan for providing glasses for the men and the fact that eye injuries in the plants of this company have been cut down to a minimum proves the value of having workmen protect their eyes in shops. The Crane Co. posted signs conspicuously at various points in its shop, directing the attention of the men to the necessity of using glasses and the fact that they would be furnished by the company free of charge.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Alloy Foundry Co., Akron, O., has increased its capital from $1,000 to $25,000.

Eagles, Hogan & Sterling will start a brass foundry in St. John, N. B., Can.

The Michigan Steel Castings Co., Detroit, has increased its capital stock from $90,000 to $210,000.

The brass foundry of E. T. Woods, Lyndonville, Vt., has been purchased by S. P. Harriman.

J. J. Aga has purchased the foundry and machine business of the Thief River Iron Works, Thief River Falls, Minn.

The Ansonia Foundry Co., Ansonia, Conn., has been incorporated with $5,000 capital by William Olderman, Michael Michaelson and others.

The Standard Plating & Brass Foundry Co., Anderson, Ind., has been incorporated with $5,000 capital by G. A. Robinson, O. H. Furr and A. H. Gillespie.

The Marshall Car Wheel & Foundry Co., Marshall, Tex., has been incorporated with $100,000 capital, by E. J. Fry, Chas. Cobb Jr., and M. Turney.

The Lewistown Foundry & Machine Co., Lewistown, Pa., has just completed an addition to its shop, which will give employment to 20 more men.

The Cowanshannock Coal & Coke Co., Yatesboro, Pa., has installed a brass foundry for the manufacture of the castings required in its own operations.

The Poteau Foundry & Machine Co., Poteau, Okla., has been incorporated with $25,000 capital by C. C. Clinton, Calhoun, Okla.; Frank E. Tyler and C. Whalen, Kansas City.

Lange & Landry, Richardson building, Columbia street, Newark, N. J., have started in the casting business and will make a specialty of gold, silver and bronze castings.

The Schmelzer & Arthur Mfg. Co., Springfield, Mass., has been incorporated with a capital stock of $50,000 to operate a foundry and machine shop. A. C. Schmelzer and B. F. Arthur are the incorporators.

The Atlas Brass Mfg. Co., Chicago, has been incorporated with a capital stock of $10,000 to operate a brass foundry. The incorporators are F. P. Roy, A. M. Roy and B. J. Brahney, 4011 West Van Buren street.

The Mechanical Products Co., Chicago, has been incorporated with a capital of $2,500 to manufacture castings, implements, tools and machinery. The incorporators are Bruno Pascale, E. R. Hartigan and C. W. Palzer, 112 West Adams street.

The Sharp Foundry & Machine Co., New Philadelphia, O., has changed its name to the Sharp Mfg. & Supply Co. and will manufacture mill, mine and factory supplies in addition to gray iron castings and mine and clay works equipment.

The McCormick Mfg. & Supply Co., Ltd., Welland, Ont., has been incorporated with a capital stock of $40,000 to engage in the brass foundry business. Frank H. Rice, Melvin Misner, C. L. Cooper and L. A. Glessman are the incorporators.

The Engineering & Foundry Co., Stockton, Cal., has been incorporated with $100,000 capital to engage in machine and foundry work. The incorporators are L. F. Grimsley, S. G. Mix, M. Davidson, L. L. Miller and J. W. Hannah.

The Canada Iron Foundries, Ltd., Montreal, has been incorporated with $4,500,000 capital to take over the Canada Iron Corp., Ltd., plants at Midland, Ont., and Three Rivers, Que. The incorporators are W. R. L. Shanks, F. G. Bush and G. R. Drennan.

The Rudy Furnace & Stove Co., Dowagiac, Mich., has been organized with a capital of $250,000 by A. E. Rudolphi, president; E. Gilbert, secretary and treasurer, who with the following constitute the board of directors: C. A. Pattison, J. D. Clary and P. F. Rudolphi.

The Kokomo Foundry & Machine Co., Kokomo, Ind., has been incorporated with $30,000 capital to engage in the manufacture of automatic, forced-draft, underfeed stokers for boilers. T. O. Callis, is president; H. L. Draper, general manager, and Lain Johnson, chief engineer.

The Columbus Foundry Co., Columbus, O., has been organized by Frank Phillips, former foundry superintendent of the Caldwell & Drake Iron Works Co., and four others. The new firm has taken over the foundry department of the Alexander Spreader Co., at the old Janney plant, East Seventeenth street.

The Stoney Foundry Corp., North Tonawanda, N. Y., recently incorporated, has leased a part of the Niagara Radiator & Boiler Co.'s foundry for the purpose of making gray iron automobile castings. The officers of the Stoney corporation are: President, E. C. Andrews; vice president, John T. Stoney and secretary and treasurer, A. M. Everhart.

The Smith's Falls Brass & Aluminum Foundry Co., Ltd., Smith's Falls, Ont., Can., has been incorporated with $60,000 capital to engage in the manufacture of brass, bronze and aluminum castings and other metal specialties. The incorporators are J. McEwen, J. MacDonald and M. G. Henniger. The new company contemplates the erection of a plant at a cost of approximately $15,000. Bids for the new building are being called for by F. Kassel.

New Construction

The Winona Foundry Co., Winona, Minn., will erect a foundry at a cost of $5,000.

The Minster Machine Co., Minster, O., contemplates the erection of a foundry addition.

The St. Clair Foundry Co., Toronto, Ont., will erect a $2,000 addition to its plant.

The McInnes Foundry Co., Wellsburg, W. Va., is erecting an addition to its plant.

The Graf Stove & Range Co., Louisville, Ky., will erect a foundry and finishing plant.

The H. D. Smith Co., Southington, Conn., will erect a large foundry.

The Gardner General Foundry Co., Gardner, Mass., contemplates erecting an addition.

Bruce Stewart & Co., Charlottetown, P. E. I., will rebuild their foundry and blacksmith shop, which was recently destroyed by fire.

The Weir Stove Co., Taunton, Mass., has let the contract for a 1-story, 65 x 150-foot foundry.

The American Rotary Valve Co., Anderson, Ind., is erecting a foundry to replace the one recently destroyed by fire.

The Doehler Die Castings Co., Toledo, O., contemplates the erection of a plant containing 60,000 square feet of floor space.

The Union Foundry Co., Boyerton, Pa., will erect an addition to its plant, 30 x 55 feet.

Plans have been prepared for several build-

ings to be erected for the R. P. Power Foundry Co., Worcester, Mass.

The Miami Brass Foundry Co., Dayton, O., plans to erect a foundry on a site adjoining its plant which has recently been acquired.

Plans have been prepared for a foundry building, 81 x 210 feet, to be erected for the Malleable Iron Fittings Co., Branford, Conn.

The Lake Erie Smelting & Refining Co., Cleveland, will erect a 2-story addition to its plant to be used for metallurgical and refining purposes.

The Pierce, Butler & Pierce Mfg. Corp., Syracuse, N. Y., has awarded the contract for the construction of a 2-story, 40 x 65-feet pattern storage building.

The Moser Pattern & Foundry Co., Newark, O., contemplates the erection of a gray iron foundry and will enlarge its pattern shop and aluminum foundry.

Maher & Flockhart, Newark, N. J., are extending their foundry by the erection of two 1-story, steel and concrete structures, 21 x 60 and 39 x 47 feet, respectively.

The Alma Standard Foundry Mfg. Co., Alma, Mich., will enlarge its plant as a result of a contract with the Ann Arbor railroad to furnish all castings for the railroad for 1915.

The United States Cast Iron Pipe & Foundry Co., Bessemer, Ala., will build an addition to its plant at a cost of approximately $50,000.

The Allyne-Ryan Foundry Co., Aetna road and East Ninety-first street, Cleveland, will erect a foundry, 80 x 112 feet, to cost $12,000.

The Union Mfg. Co., New Britain, Conn., will build a 5-story, 47 x 160-foot addition. The company manufactures chucks and castings.

The H. H. Franklin Mfg. Co., Syracuse, N. Y., manufacturer of automobiles and castings, will build a die casting plant, 53 x 100 feet, at a cost of approximately $25,000.

The Simmons Mfg. Co., Kenosha, Wis., is erecting a 6-story building, 400 x 80 feet. The contract for the steel work has been awarded to the Kenwood Bridge Co., Chicago.

Contract has been awarded for the erection of a $12,500, 1-story brick addition to the plant of George B. Limbert & Co., 557 Fulton street, Chicago, manufacturer of steam fitters' supplies.

The Belmont Iron Works, Philadelphia, has been awarded the contract for the construction of a 60 x 100-foot iron foundry, to be erected on Westmoreland street, east of Richmond street, for the General Smelting Co.

The Chicago Faucet Co., 313 South Clinton street, Chicago, manufacturer of plumbers' supplies, will construct a foundry and machine shop, 50 x 125 feet. The foundry equipment will be purchased in the near future.

The American Ship Building Co., Cleveland, contemplates the construction of a foundry and machine shop, 120 x 320 feet; a 2-story pattern shop and pattern storage building, 100 x 200 feet, and a 3-story office building, 60 x 100 feet, on the Globe ship yard site at the foot of West Fifty-fourth street.

The Osborn Machine Co., Dubois, Pa., contemplates the erection of a foundry, 50 x 140 feet, with a capacity of from six to 15 tons of railroad castings daily. This company is in the market for a second-hand electric traveling crane with a span of from 20 to 25 feet. A cupola and other foundry equipment also will be purchased.

The West Steel Casting Co., Cleveland, manufacturer of converter and crucible steel castings, recently has purchased a tract of land adjoining its plant, on which two additional steel structures are being erected, respectively 53 x 120 feet and 53 x 100 feet. This addition to the foundry will considerably increase the molding floor area. Two traveling cranes, a drying oven, sand mixing tub and several additional molding machines will be installed. The new buidings will be ready for occupancy within about three months.

The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., shortly will dismantle its light work foundry located on the North Side, Pittsburgh, and the castings heretofore made in this plant will be produced at the company's shop in Cleveland. A large part of the heavy work now being made at the Cleveland foundry will be manufactured at the Westinghouse Machine Co.'s casting plant at Trafford City, Pa. Some heavy work also will be made at the Cleveland plant, but to a large extent this shop will be devoted to light work. At the Cleveland plant one of the foundries will be torn down to provide a site for an 8-story pattern warehouse, 70 x 200 feet. Contracts for this building have been awarded. The Cleveland foundry, located on West Fifty-eighth street, will be arranged to operate on the continuous basis by the grating, shake-out and sand conveyor system. Iron will be melted throughout the day and the molds will be poured as rapidly as they are made. The castings will be shaken-out on their respective floors, the sand being dropped through a grating into a sand conveyor in a basement underneath the shop. In this basement the sand will be cooled and tempered for delivery to the molding floors. The number of cupolas in this shop will be reduced from seven to five, although by this continuous system of operation the output will continue practically the same as in the past, which approximates about 2,000 tons per month. The cleaning equipment also will be greatly extended by the installation of additional sand blast machines and tumbling barrels.

NEW TRADE PUBLICATIONS

SIROCCO PRODUCTS. — An exceedingly handsome, 32-page catalog devoted to heating, ventilating and humidifying by the fan system, has been issued by the American Blower Co., Detroit. The Sirocco fan, built on the many-blade plan, is the blowing unit of this system for heating, ventilating and air conditioning. A large number of illustrations are included showing various buildings and plants in which this system has been installed.

PORTABLE AIR COMPRESSORS.—A 32-page bulletin, issued by the Ingersoll-Rand Co., New York City, is devoted to portable air compressing outfits developed expressly for manufacturing plants, contractors, mine operators and others employing air tools with work of a temporary or semi-permanent character. A list of bulletins describing in detail each particular line of portable compressors is included. Another bulletin issued by this company discusses a mounting for "Jackhammer" drills.

DRILL AND GRINDER.—Two circulars have been issued by the Stow Mfg. Co., Binghamton, N. Y., devoted respectively to a new type ½-inch electric breast drill and to a tool post grinder, both hand feed and plain. The breast drill can be operated either by alternating or direct current. The tool post grinder is adapted for grinding centers, dies, cutters, etc., and does both internal and surface grinding. It is supplied with a ⅜ x 6-inch emery wheel, internal grinding attachment, flexible cord and plug to fit any standard lamp socket.

ELECTRIC ARC WELDING. — "Variable Voltage Arc Welders" is the title of a 16-page bulletin issued by the Welding Materials Co., 114 Liberty street, New York City. The subject of electric arc welding is considered at length and suggestions for both welding and cutting by this method are described in detail. Numerous illustrations are included showing welds made by this process, including motor frames, street railway truck frames, steel plates, barrels, cylinders, etc. The welding outfit also is illustrated, including the electrode holder, shields for the protection of operators, etc.

ELECTRIC FURNACE BULLETIN. — A handsomely illustrated, 24-page bulletin has been issued by the Snyder Electric Furnace Co., Chicago, which is devoted to the Snyder furnace and shows various installations of this steel-refining medium. Not only is the furnace described in detail, but the method of making steel by this process also is discussed. Another booklet also issued by this company is entitled "A Better Steel at a Cost Lower Than Open-Hearth for Equal Tonnages." The merits of the Snyder furnace are pointed out briefly with comparisons of its efficiency with open-hearth furnaces.

FOUNDRY EQUIPMENT. — A series of bulletins has been issued by the Coleman Foundry Equipment Co., Cleveland, which illustrate and describe the extensive line of foundry equipment built by this company. One bulletin is devoted to natural draft, coke burning crucible furnaces, which are described in detail and one of the many installations of this type of melting medium is shown. A 16-page bulletin is devoted to ovens for drying cores and molds. Large installations of the rolling drawer type are shown, as well as combination car and rolling drawer ovens. In addition, other bulletins are devoted to a squeezer molding machine, water tumbling mill, sprue cutter and aluminum furnaces.

BRUSHES, BROOMS AND FOUNDRY SUPPLIES.—The extensive line of brushes, brooms, foundry supplies and hardware specialties manufactured by the Osborn Mfg. Co., Cleveland, is illustrated and described in a 302-page catalog recently issued. To facilitate the insertion of revised sheets the catalog is bound in a loose-leaf binder. The line of brushes and brooms illustrated is exceedingly extensive and includes practically every conceivable type for almost every purpose. Practically every type of molder's brush is made, as well as casting brushes, both hand and wheel. Brushes, polishing and buffing wheels also are made for use in polishing and plating departments. A line of foundry supplies in addition to brushes, brooms, etc., includes wire cloth, bellows, shovels, sprinkling cans, rammers, sprues, mallets, spray cans, torches, sand sifters, etc. A line of brushes also is shown for use in the pattern shop, including glue and paint brushes, etc. The catalog is unusually complete and should prove a valuable addition to the trade literature of every manufacturing plant.